



Kings County Water District
Apex Ranch Conjunctive Use Project
Groundwater Monitoring Program

Results of Operations

From

October 2010 through September 2011

Prepared:

December 2011

By

Provost & Pritchard Consulting Group



In Association with

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DATE SIGNED: 12/14/12

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SECTION 1. INTRODUCTION

1.1. District History

Kings County Water District (District) was established in 1954, and currently consists of approximately 150,000 acres. The primary function of the District is to conserve water, make available local and imported surface supplies, and stabilize a reasonable water table in the upper strata beneath the District's service area. Water for the District's programs comes from many sources, but originates generally in the Kings and Kaweah Rivers and is conveyed to irrigate lands, settling basins, sloughs and depressions where it can percolate underground.

The four-point program outlined below was established at the Districts founding, and covers the Districts basic aims:

- To protect, conserve and stabilize the underground supply of water.
- To contract develop for new sources of water.
- To maintain the facilities and capabilities to utilize and conserve those supplies that become available.
- To preserve existing water rights.

1.2. Project Background

The intention of the Apex Ranch Groundwater Conjunctive Use Project (Project) since its inception in 2002 is to store Kings River water during periods when water is available and recover groundwater during periods of water scarcity. Recharge to local groundwater during Project operations would resemble historical recharge patterns when the river flowed through the old channel, rather than under present conditions, where this channel has been bypassed by the river. There was concern with neighboring landowners at Project conception that groundwater levels would rise during recharge operations and cause root zone flooding. There was also concern that during Project recovery, water levels among off-site grower wells would decline excessively, resulting in increased pumping costs or even forcing wells out of production. The Kings County Water District has been and continues to be committed to managing the Project so that negative impacts caused by Project operations are either avoided or adequately mitigated. The location of the site in relationship to the District is shown on **Plate 1**.

1.2.1 *2011 Yearly Summary*

It should be noted that water levels in the District decline regionally during dry periods and rise during wet periods. **Figure 1-1** contains hydrographs showing regional long-term water level variations in five private wells within an approximate two-mile vicinity of the Project (in T17S/R22E). Water levels in all of the five wells

rose during the 2011 water year. Of note, the two regional wells east of the Project, 24E1, and 18E1 saw a rise of approximately 10 feet while the wells west of the Project and along the Old River saw a rise in levels from 20 to 35 feet. **Figures 1-1.1-1.5** are individual long-term hydrographs for these wells.

Figure 1-2 is a hydrograph that depicts the average District water level as well as the percent Kings River water year. 100 percent equates to an average or normal year. As is shown, there are years with hydrologic conditions that are close to an average year. Typically, the annual hydrologic conditions tend to be wetter or drier than an average year. The hydrograph shows that the average depth to water in measured wells in the District rose approximately 16 feet in 2011 from the 2010 average, which was the deepest on record (over 140 feet.) It should also be noted that the decline in level from 1986 to the present was about 85 feet in 25 years, or an average of 3.4 feet per year. Also shown on the figure is the change in levels in wells in Township 17S, Range 22E, which represents the area bounded by Hwy 43 on the west, Excelsior Avenue on the south, the Kings County line on the East and Cole Slough on the North. As is shown on the hydrograph, the decline over the same time was 38 feet, or an average of 1.5 feet per year. The average depth to water in measured wells in Township 17S, Range 22E was about 58 feet in Fall 2011, which lessened the depth to water by approximately 20 feet since Spring 2011, and is similar to the levels in 1990. The average regional water level hydrograph for this entire township and range is similar to the hydrograph for the 5 regional wells (**Figure 1.1**) near the Project and can be used to characterize the local regional area related to groundwater level and trends.

Recharge for the Project during the 2011 water year occurred during the months of December 2010 to July 2011 with three distinct periods consisting of December 20 to February 16, March 2 to March 8, and March 22 to July 12. Recovery operations for the Project did not occur during the 2011 water year.

Note: The 2011 water year was a 170% water year for the Kings River compared to the long-term average.

Figure 1-3 shows water level readings for the Apex wells in relationship to the regional wells and the wells in the District system for Township 17S, Range 22E.

1.3. Scope of Report

This report summarizes the recharge and recovery operations for the 2011 water year (October 1, 2010 – September 30, 2011) for review by the Monitoring Committee and the District; provides water level measurements for wells within the monitoring network, and summarizes the results of water quality sampling.

1.4. Observations/Recommendations

In the spring of 2011, the District agreed to hire an outside consultant to perform a third-party review of the operations of the Project and provide any recommendations to improving the Project operations for the benefit of the District

and the local landowners. These recommendations have been developed and expressed in a memorandum, which is included as **Appendix E**.

1.4.1 2012 Update to 2004 Monitoring Program Guidelines

Included as **Appendix F**, is the 2012 Update to the 2004 Project monitoring program guidelines. These guidelines were updated and are scheduled to be approved by the District Board of Directors in the first quarter of the 2012 water year. The update is based on recommendations provided by the third-party consultant, review of operations, the District Manager, District Engineer and District Hydrogeologist.

1.5. Board Authorizations

On September 1, 2011 at its regularly scheduled meeting, the Board of Directors authorized the construction of four nested monitor wells. These wells are anticipated to be completed and in-place during the winter months of water year 2012.

On October 6, 2011 at its regularly scheduled meeting, the Board of Directors authorized the emergency Old River repairs to Dam A, Dam 1, Dam 2, Dam 4 and Dam 6. These repairs are anticipated to be completed and in-place prior to pending flood releases on the Kings River.

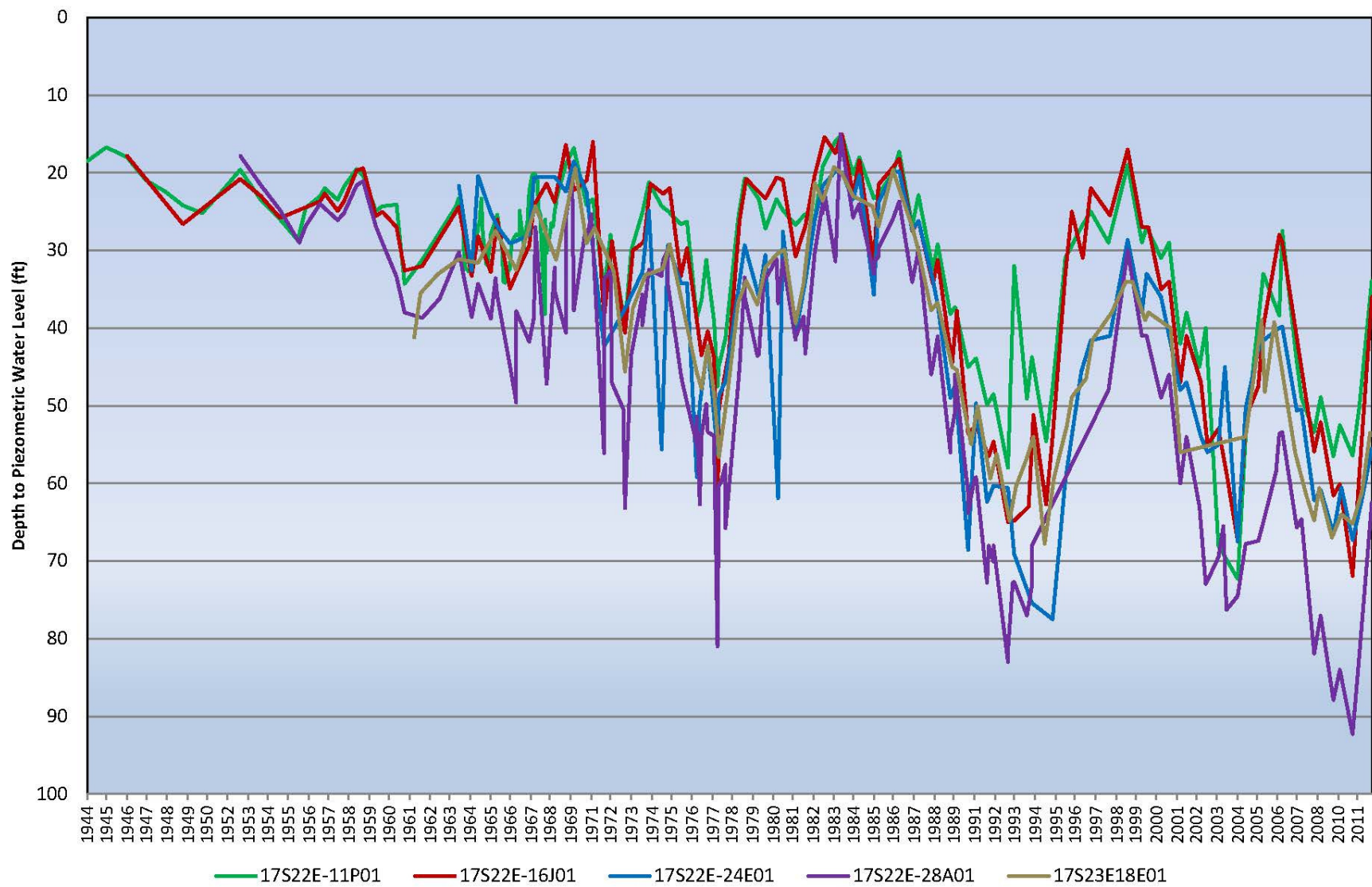


Figure 1-1: Regional Long-Term Hydrograph Fall 1944 thru Fall 2011

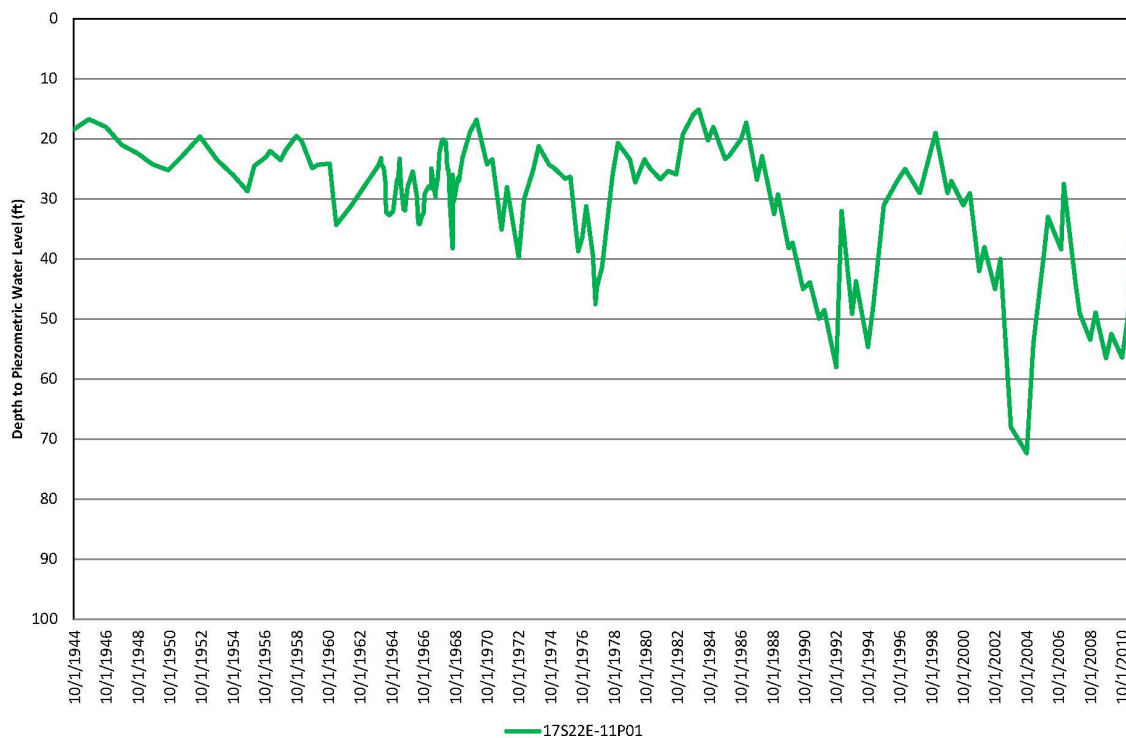


Figure 1-1.1: Long-Term Hydrograph - State Well ID 17S22E11P01

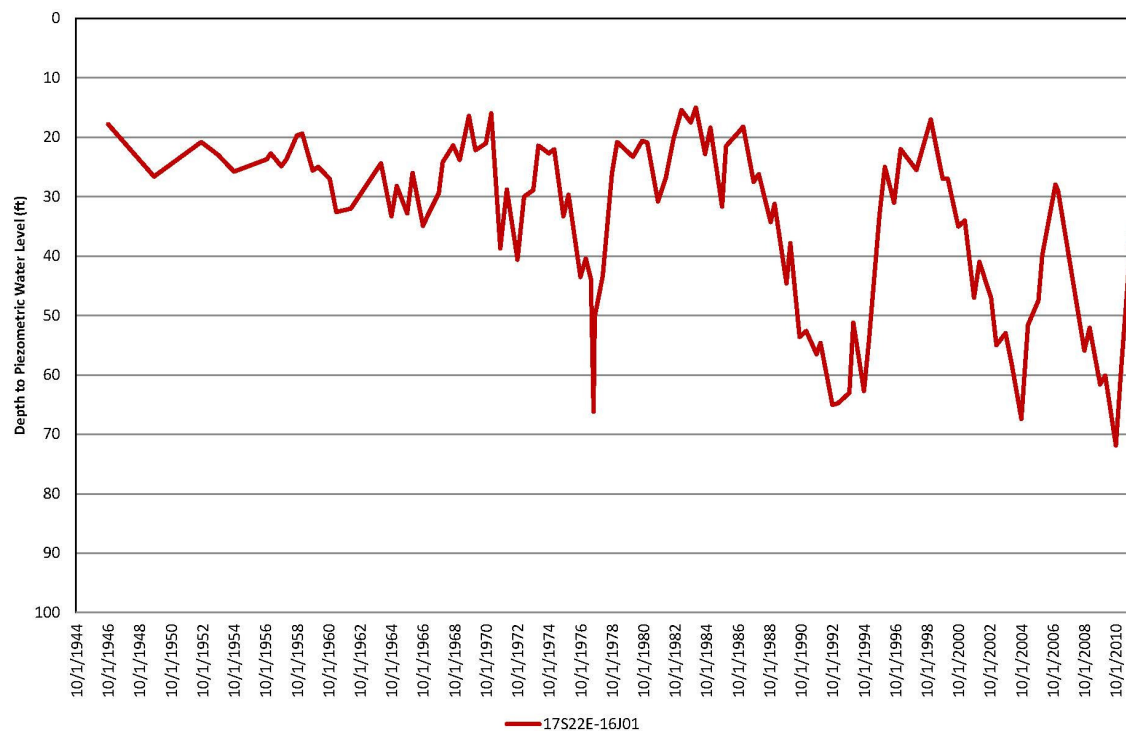


Figure 1-1.2: Long-Term Hydrograph - State Well ID 17S22E16J01

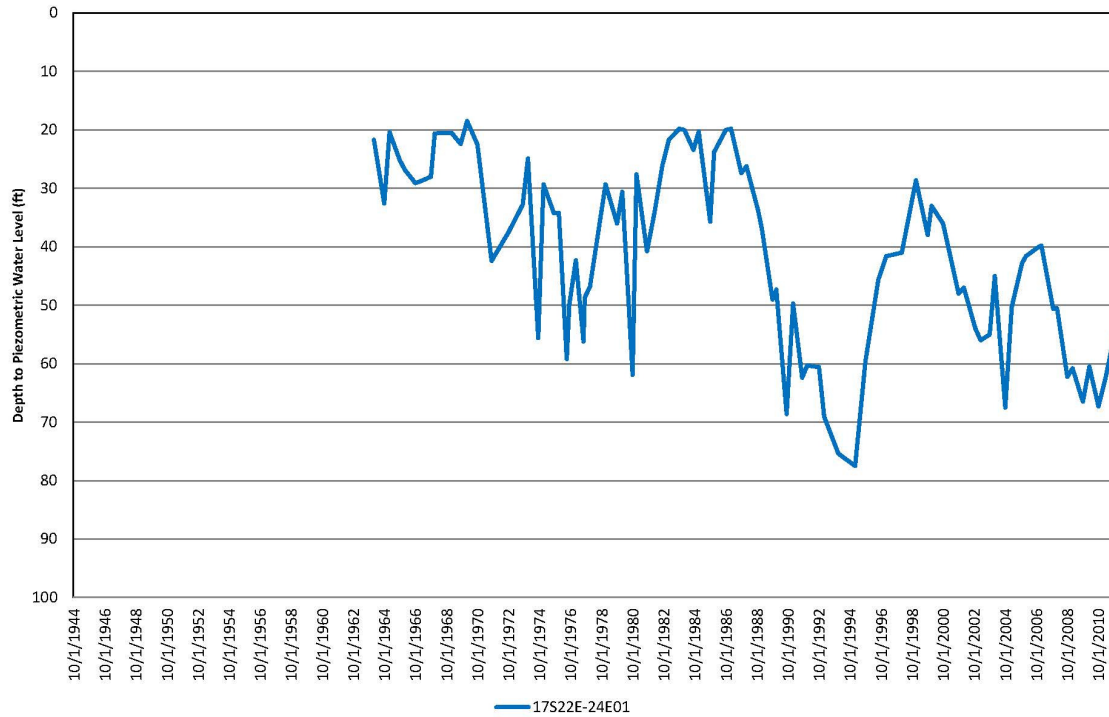


Figure 1-1.3: Long-Term Hydrograph - State Well ID 17S22E24E01

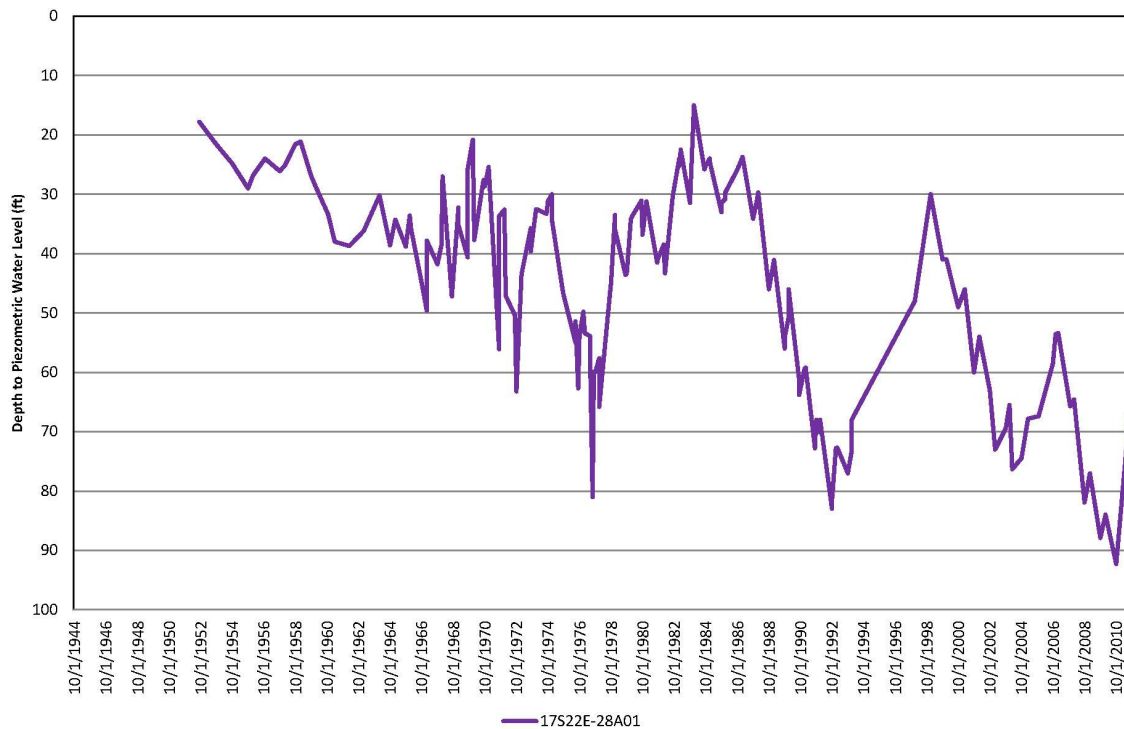


Figure 1-1.4: Long-Term Hydrograph - State Well ID 17S22E28A01



Figure 1-1.5: Long-Term Hydrograph - State Well ID 17S23E18E01

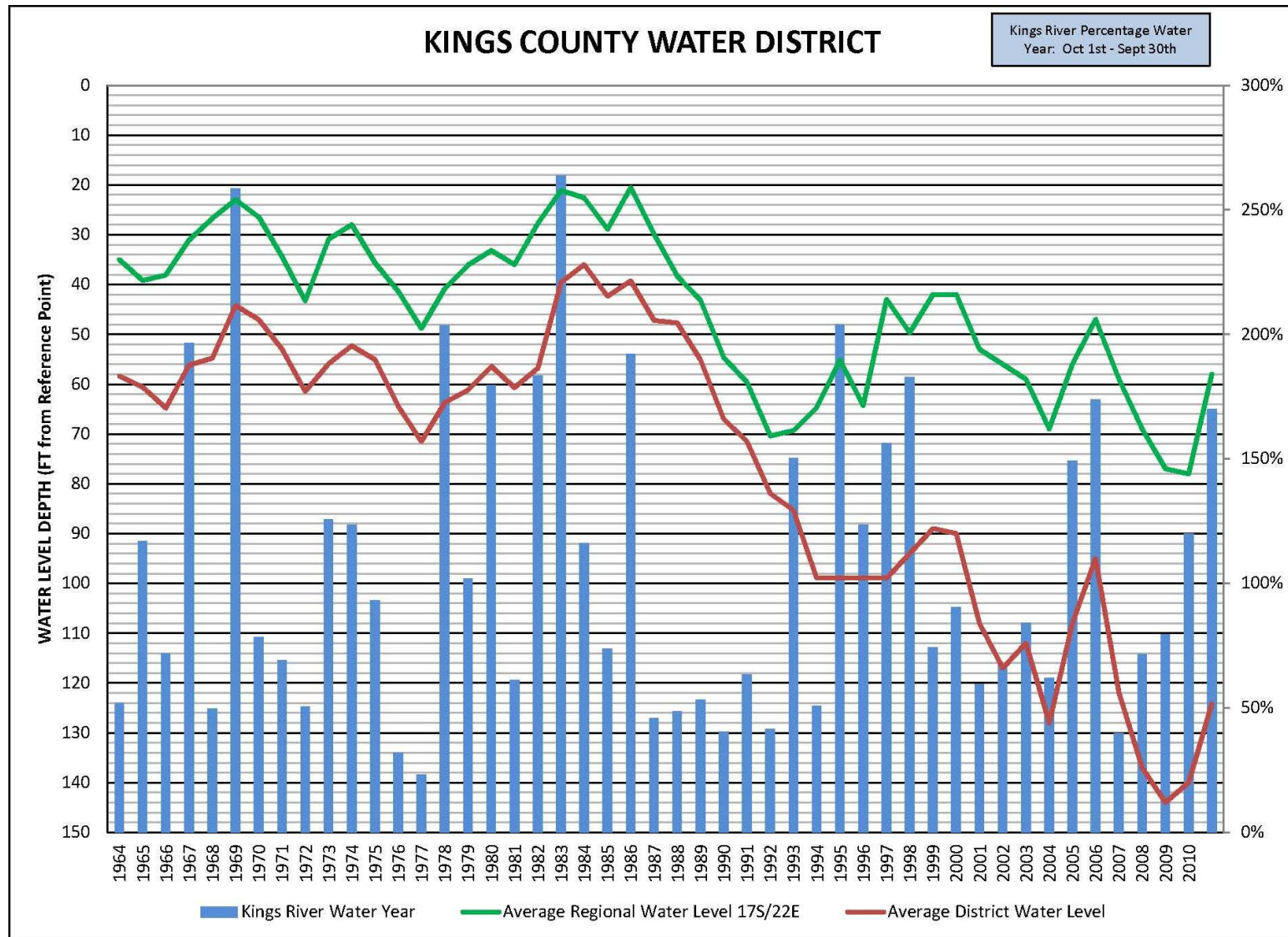


Figure 1-2: Average Fall Depth to Water (1964-2011) in 17S/22E vs. Whole Kings County Water District

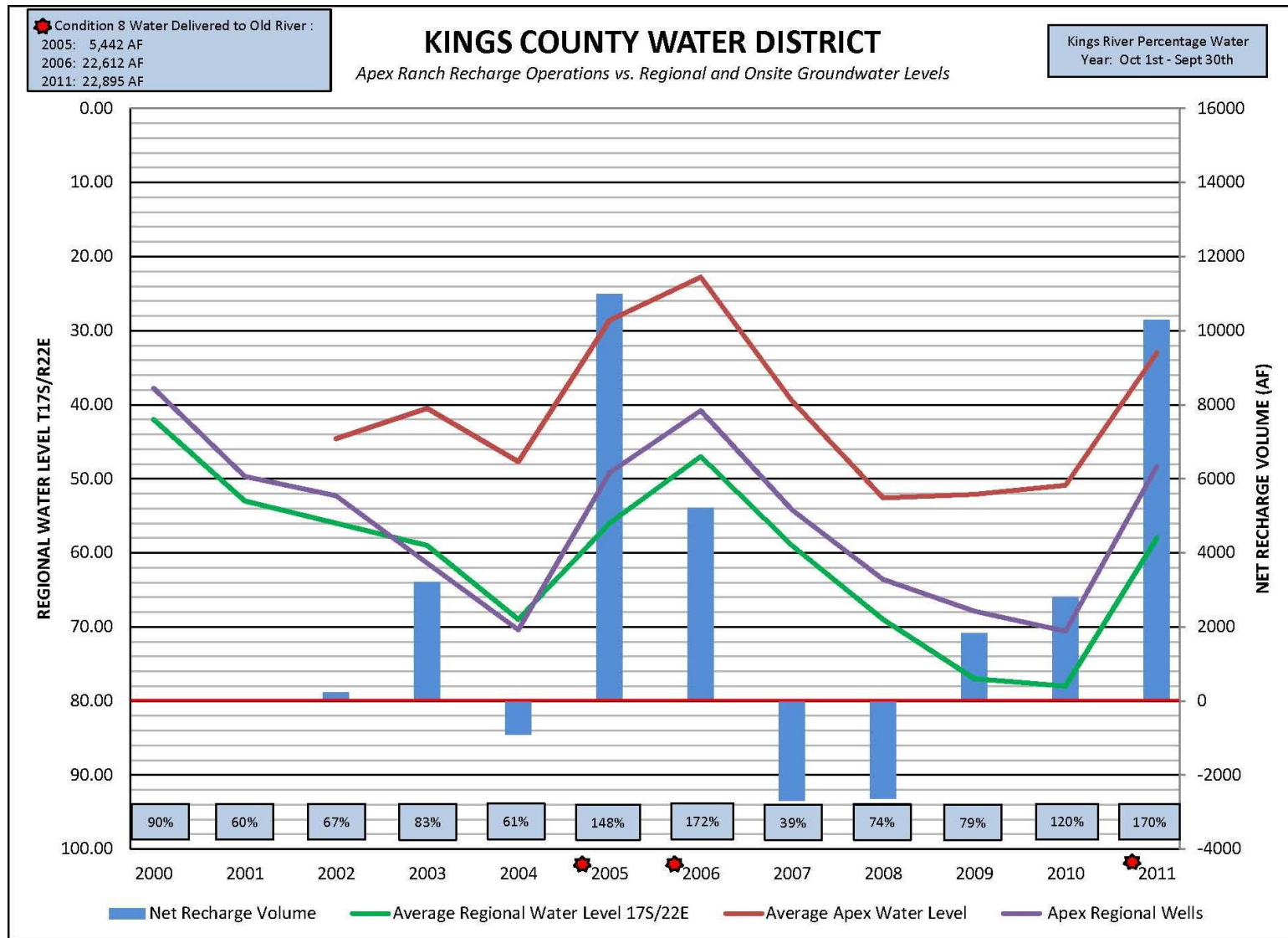


Figure 1-3: Apex Ranch Recharge Operations vs. Regional and Onsite Groundwater Levels

SECTION 2. DESCRIPTION OF GROUNDWATER MONITORING PROGRAM

2.1. Program Objectives

The Apex Ranch Groundwater Monitoring Program (GMP) is used to guide the District's efforts to track recharge and recovery pumping operations, groundwater levels and groundwater quality. This effort has been conducted to help alleviate concerns regarding Project impacts on adjacent landowners.

Restated - The objectives of the GMP are to provide the District and the Monitoring Committee (Committee) with documented information for the development of a program that will allow the District and Committee to:

- A. Determine long-term recharge effectiveness for the facility;
- B. Evaluate the effect of groundwater recharge on shallow groundwater levels beneath and adjacent to the facility;
- C. Determine drawdown during recovery well pumping in zones tapped by nearby water supply wells;
- D. Evaluate development of operation and maintenance procedures to maintain or enhance recharge rates;
- E. Evaluate need for measures to increase recharge rates, should long-term rates be found inadequate;
- F. Evaluate need for measures to reduce groundwater mounding should it be found to adversely affect properties or public facilities adjacent to the facility;
- G. Determine measures to limit drawdown in water supply wells within the area as needed;
- H. Evaluate ability to monitor Project operations and to allow controls so that the Project accomplishes the goals of developing additional water supplies while not negatively affecting neighboring landowners;
- I. Evaluate effect of groundwater recharge on local groundwater quality.

2.2. Monitoring Committee

The Monitoring Committee was established on April 8, 2002. The goal of the Committee has been, and will be, to provide oversight to the District regarding the operation of the Project. The Committee is comprised of members of local agencies and local landowners.

2011 Committee Members:

Dale Kuntz - *President*
Bob Giacomazzi - *Vice-President*
Bill Tos
David TeVelde
Larry Workman

The committee provides guidance to the District in response to local concerns based on review of the monitoring data and Project operations. The committee is entrusted with evaluating local conditions associated with the Apex Ranch Conjunctive Use Project based on the summarized monitoring data and communications with District personnel. Meetings are set as needed to keep the Committee informed of the Project operations.

2.3. Groundwater Monitoring Program

The March 2004 Groundwater Monitoring Program Report, has been utilized as the guideline for the monitoring efforts during Project operations, with the exception of water year 2009. In an effort to alleviate the concerns of local landowners, the District modified the Monitoring Program for much of the 2009 water year by instituting a Monitoring and Mitigation Plan for the 2009 Summer Recovery Pumping Operations. However, because the increased monitoring efforts that were conducted under the monitoring and mitigation plan did not produce more beneficial information than what was produced during previous operations, the District's Board of Directors reinstated the March 2004 Groundwater Monitoring Program as the basis for the monitoring efforts beginning in the 2010 water year. **Plate 2** provides a map of the Project area and locations that were monitored under the 2011 water year monitoring network.

The following table identifies the number of wells within the District's monitoring network from 2002 to 2011.

Water Year	Onsite Wells	Offsite Wells	Network Total
2002	9	5	14
2003	9	5	14
2004	12	12	24
2005	20	9	29
2006	21	11	32
2007	22	18	40
2008	24	18	42
2009	25	55	80
2010	25	23	48
2011	25	23	48

2.3.1 Onsite Monitoring Program

The onsite component of the GMP is a network of wells consisting of five recovery wells, three monitor wells, eight agricultural wells, one unused agricultural well, four domestic wells and four shallow well points. A map of the onsite-monitoring network is provided on **Plate 3**. As part of the continuing effort to closely monitor the onsite groundwater levels on a daily basis; Recovery Well 5, Monitor Wells 1, 2 and 3, Ranch Well 17 and Domestic Well 4 were equipped with continuous water level recorders (data loggers) throughout the 2011 water year. The data obtained from the continuous recorders, provided information on the deep, shallow, and intermediate zones. For the discussion here, the shallow zone is identified as 100 foot or shallower, the intermediate zone from 100 feet to 250 feet in depth, and the deep zone for wells deeper than 250 feet.

2.3.2 Offsite Monitoring Program

The offsite component of the GMP consists of fourteen agricultural wells, three unused agricultural wells, four domestic wells and two unused domestic wells; within two miles of the Project. These wells are regularly monitored as part of the District's overall GMP, and are considered to reflect both regional factors and identify impacts (if any) of operation of the Project. In an effort to more closely monitor offsite groundwater level changes on a daily basis, the District has installed several continuous water level recorders at several locations over the past few years. However, as conditions of those sites have changed, either because of well operations, vandalism or unused wells being destroyed, the locations of some of the continuous loggers have been relocated or been permanently removed. During 2011 there were two offsite continuous loggers that provided daily information throughout the water year. The District is striving to gain more information throughout the Project's surrounding area and is continuously trying to locate new locations for the permanent installation of continuous dataloggers. **Plate 4** is a map of the offsite monitoring network. Well construction information has been researched on all the existing wells in the network, and is not comprehensive. Available data indicate that most of these wells are completed in the shallow or intermediate zone of the aquifer.

2.3.3 Local Landowner Involvement

Although the District expects that negative impacts resulting from groundwater pumping during recovery operations are unlikely, in 2009, through an enacted mitigation plan, the District developed a mechanism by which local landowners can file a complaint with the District and a process in which the complaint can be addressed. This mechanism, follows three steps: Investigation of Third-Party Complaint, Verification of Complaint, and Complaint Resolution. This recourse was available to landowners throughout the 2011 water year. It should be noted that there were no formal complaints received during this year.

2.4. Construction Activities

2.4.1 General

No construction activities took place during the 2011 Water Year.

2.5. Recharge Operations

Appendix A reflects the monthly operations of the Project during the 2011 water year. Recharge to the Project was conducted from December 2010 – July 2011, with a total of 10,290 acre-feet being delivered for recharge. There were three recharge events during the period of December 2010 – July 2011: December 20, 2010 – February 15, 2011, March 2, 2011 – March 8, 2011, and March 22, 2011 – July 12, 2011. Water delivered to the Project was Kings River flood release, and Mill & Hughes entitlement water.

2.6. Old River Operations

Recharge operations conducted by the District within the Old River are summarized in **Appendix A** and **Plate 11**. During the 2011 water year, the District delivered 22,895 acre-feet of Condition 8 flood water to the old river channel in addition to 17,088 acre-feet of Kings River flood release for a total of 39,983 acre feet. These deliveries were conveyed through the turnout from People's Ditch at Apex Ranch, and through two turnouts from the Riverside Ditch that were constructed last year.

As summarized in **Appendix A** and **Plate 11**, the District delivered approximately 53,816 acre-feet of flood waters from the Kings River. Where of that 53,816 acre-feet, Riverside Ditch delivered 3,543 acre-feet to local landowners and 17,088 acre-feet to the Old River, 10,290 acre-feet was delivered to the Project from Peoples Ditch above Dam A, and 22,895 acre-feet was delivered to the Old River below Dam A. These deliveries are in addition to the typical surface water diversions that the District provides to the regional area.

2.7. Recovery Pumping Operations

Due to the abundant supply of surface water available for irrigation demand, the District opted to forego recovery operations from the Apex Ranch project during the 2011 water year.

SECTION 3. MONITORING RESULTS

3.1. Water Level Monitoring

In conjunction with recharge operations throughout the 2011 water year, manual water level measurements were conducted for all wells identified within the monitoring network. Water level measurements were taken at the beginning and the end of the water year to document conditions throughout the Project and the surrounding area.

During recharge operations, manual water level measurements were taken on April 5, 2011, and June 3, 2011. The April readings were in the spring prior to the longest recharge period this year. The June readings were taken prior to the initiation of local pumping for the irrigation season. In addition to the manual water level measurements, the District continued to monitor the groundwater levels with the eight continuous dataloggers that are in-place at and around the Project. Water levels were again measured on August 3, 2011 to provide groundwater levels within a month after the cessation of the recharge operations.

The 2011 water year summary of the onsite and offsite water-level measurements for the monitoring program is included in **Appendix B**.

As discussed previously, continuous water level measurements were taken with the use of transducers and dataloggers installed in eight wells and were set to take readings every day. Dataloggers were in place on October 1, 2010 and data was collected for the full year at the following locations:

- Monitor Well 1
- Monitor Well 2
- Monitor Well 3
- Recovery Well 5
- Ranch Well 17
- Domestic Well 4
- 17S22E24E01
- DT MW 2

Graphs of the hydrographs can be found in Appendix B.

3.1.1 Water Level Measurements for On-Site Wells

The on-site portion of the monitoring network for the 2011 water year included five recovery wells, three monitor wells, eight active agricultural wells, one unused agricultural well, four domestic wells and four well points. Water level trends recorded by the level loggers in the wells were consistent with manual depth to water measurements taken with electric sounders. The manual measurements are used in conjunction with the datalogger data to verify the accuracy of frequent water-level measurements and displayed in **Figures 3-1, 3-2, 3-3, 3-4, and 3-5**.

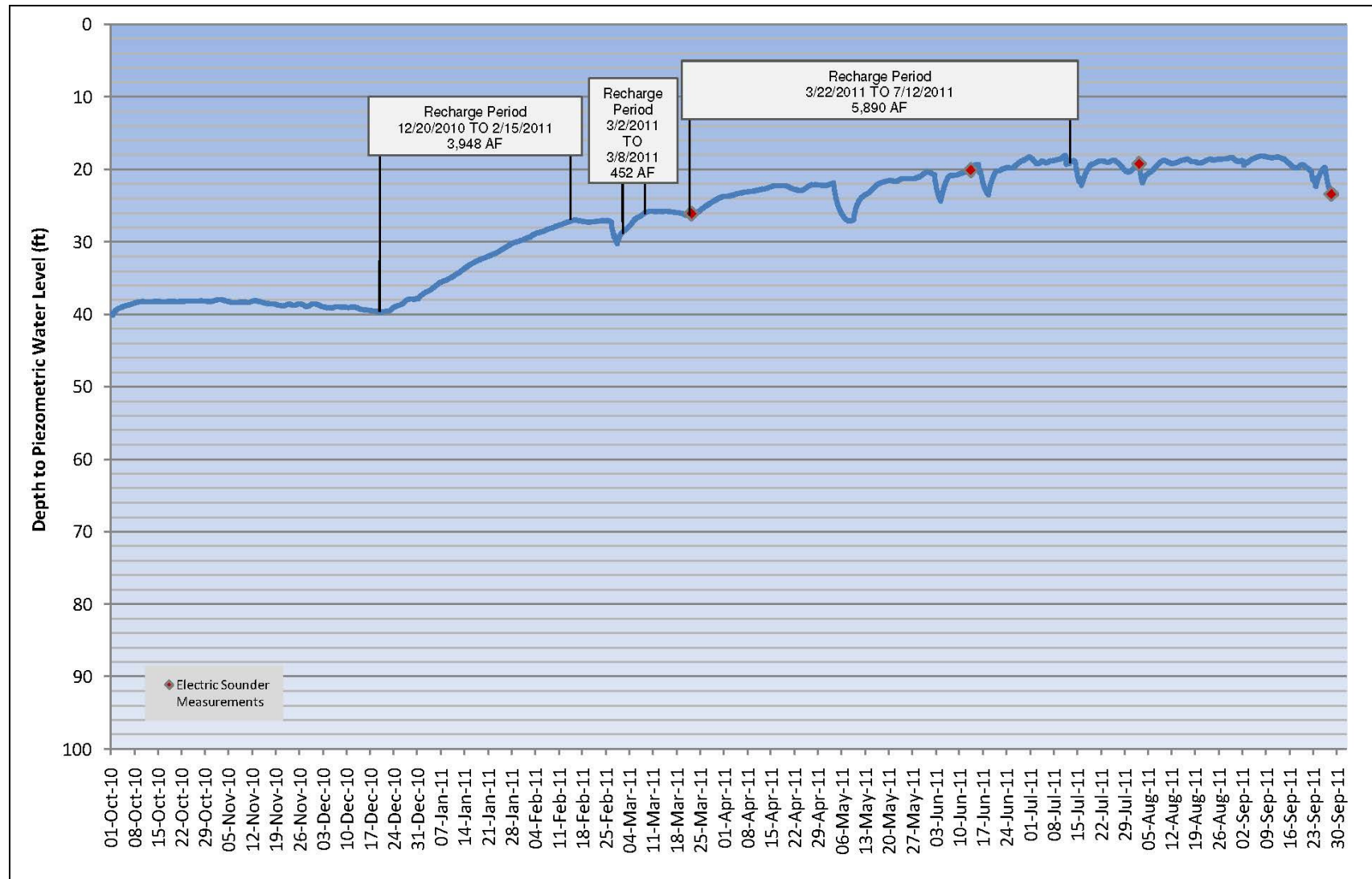


Figure 3-1: 2011 WY Monitor Well 1 Water Level Hydrograph

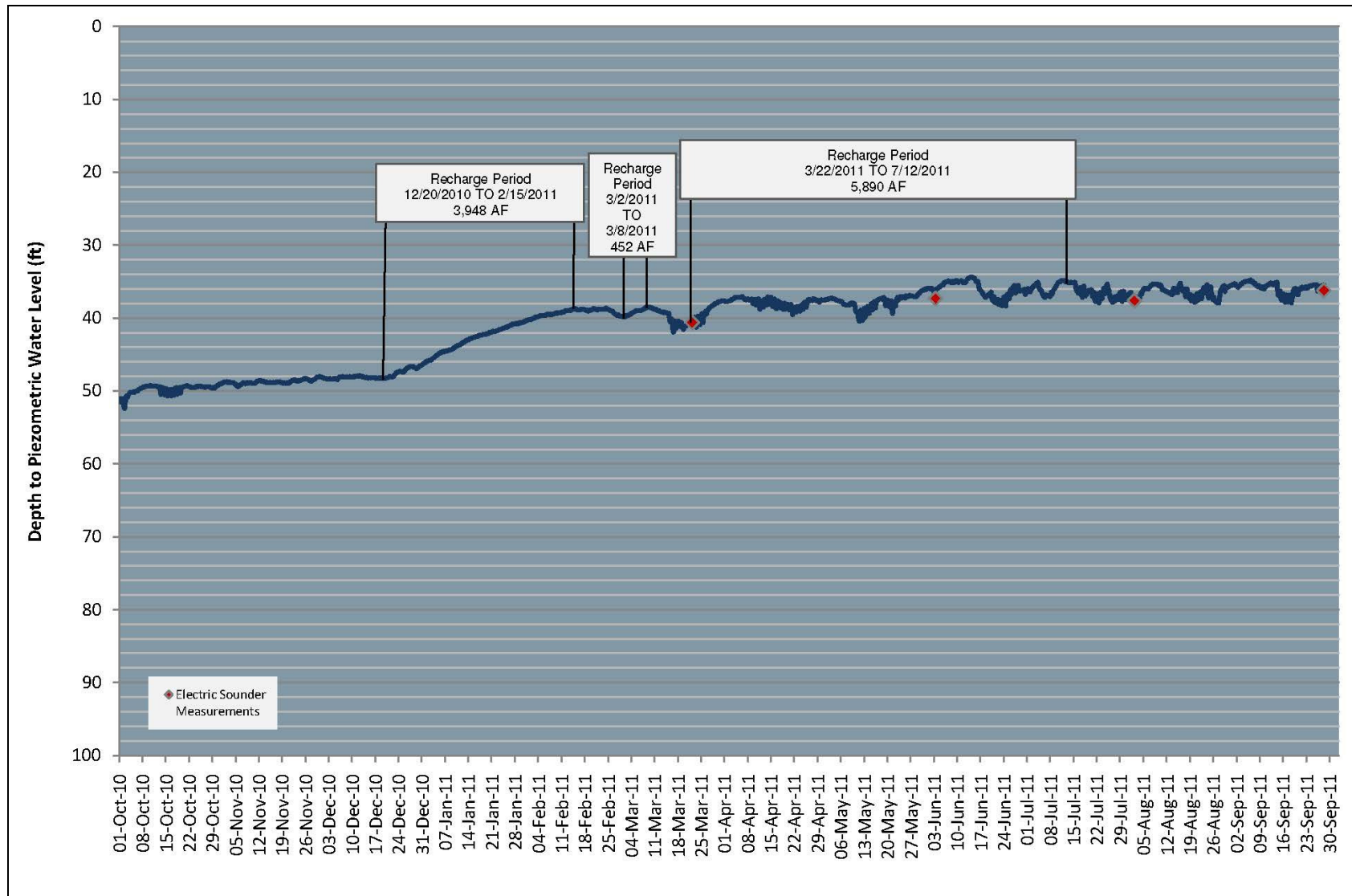


Figure 3-2: 2011 WY Monitor Well 2 Water Level Hydrograph

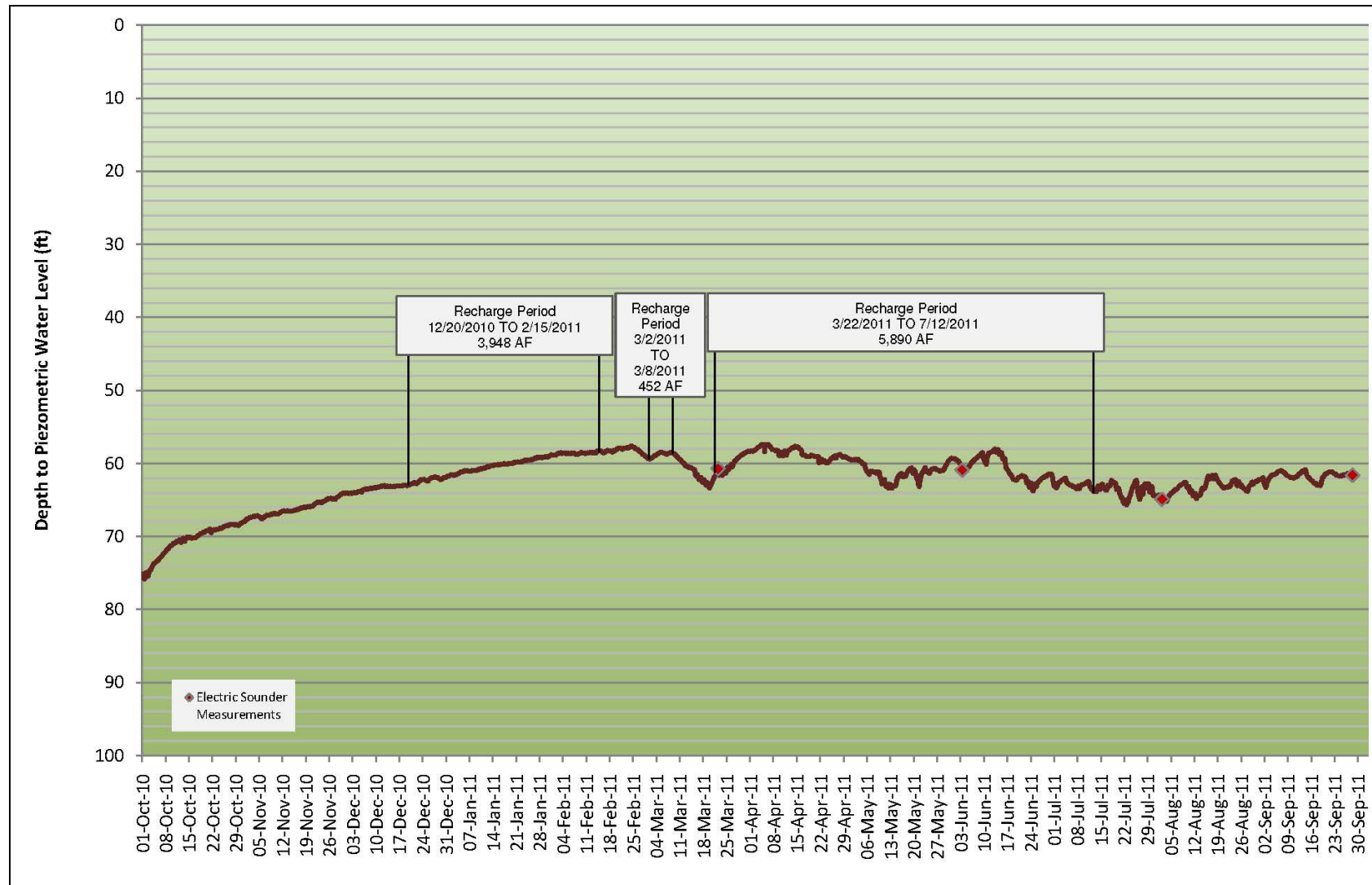


Figure 3-3: 2011 WY Monitor Well 3 Water Level Hydrograph

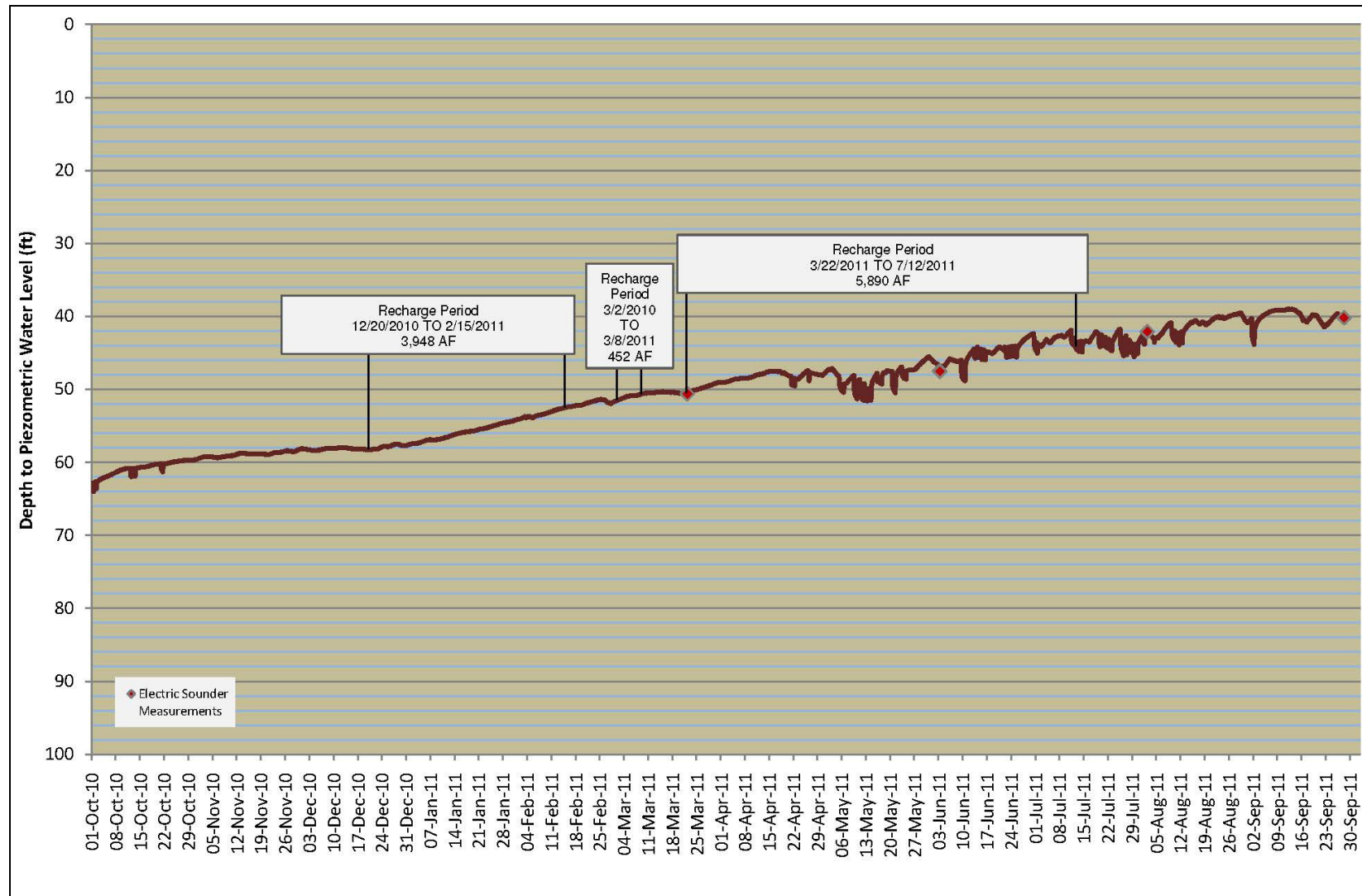


Figure 3-4: 2011 WY Ranch Well 17 Water Level Hydrograph

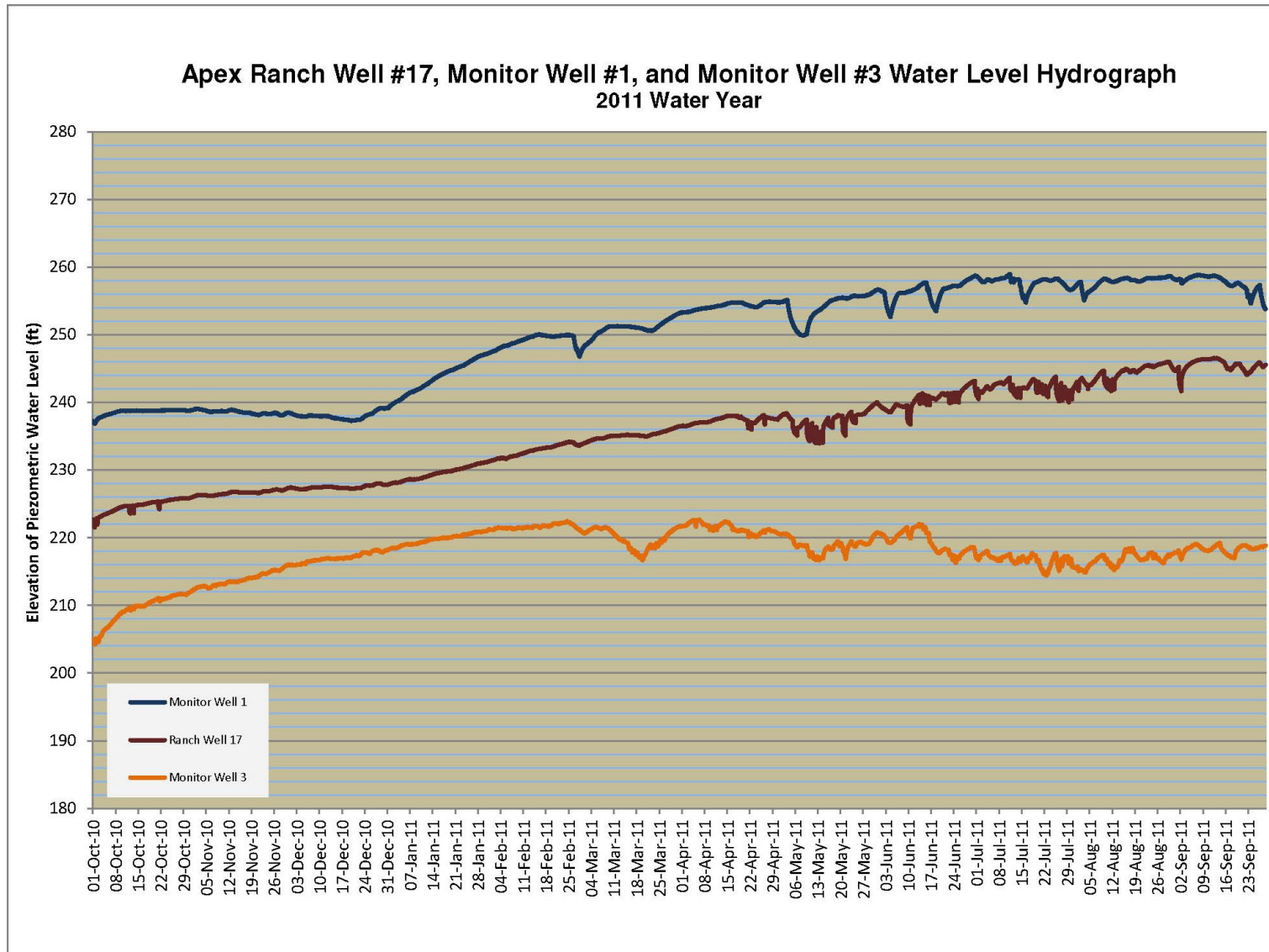


Figure 3-5: Cluster Monitor Well B, Results for 2011

Monitor Wells

Monitor Well 1

Monitor Well 1 (MW 1) is a shallow well, perforated from 30 to 50 feet in depth, and is located about 700 feet west of Recovery Well 1. **Figure 3-1** is a water level hydrograph for MW 1 covering the 2011 water year. The hydrograph indicates that recharge operations and other factors affected the water levels in MW 1. The following table summarizes changes in water level during specific periods for MW 1. It should be noted, that the small temporary water-level declines periodically seen (2 to 3 feet or less) correspond to pumping from local irrigation wells.

Monitor Well 1 Change in Groundwater level

Date	Change (ft)
10/1/2010 to 12/20/2010	-0.3
12/20/2010 to 2/15/2011	12.7
2/15/2011 to 3/2/2011	-1.5
3/2/2011 to 3/8/2011	2.7
3/8/2011 to 3/22/2011	-1.8
3/22/2011 to 7/12/2011	7.7
7/12/2011 to 9/28/2011	-4.5

The depth to water in MW 1 at the beginning of the 2011 water year was 40.0 feet below ground surface (BGS) while the water level on September 28, 2011 was 23.2 feet BGS, or a cumulative rise of 16.8 feet.

Monitor Wells 2 & 3

Monitor Well 2 (MW 2) and Monitor Well 3 (MW 3) are deep monitor wells (depths of 650 ft and 968 ft); located adjacent to Recovery Wells 2 and 3, respectively. The perforations in these monitor wells are from 210 to 650 ft and 428 to 969 ft in depth, respectively. **Figures 3-2 & 3-3** are their respective WY 2011 water level hydrographs. The hydrographs for MW 2 and MW 3 show similar fluctuations in response to recharge and recovery operations. The local irrigation wells pump from strata primarily above the perforated intervals of these wells, so the effect of pumping of the local irrigation well's on MW 2 and MW 3 is not apparent. Small water-level variations are likely due to pumping patterns of more distant deep wells (i.e. such as in the City of Kingsburg).

MW 2 and MW 3 displayed similar changes in depth to water during the 2011 WY. Water levels rose during the three recharge periods. Following the cessation

of each recharge period, water levels showed a slight decline. The table below indicates the change in water levels throughout the year for both MW 2 and MW 3.

Monitor 2 and 3 Change in groundwater levels (ft)

Date	Monitor Well 2	Monitor Well 3
10/1/2010 to 12/20/2010	3.1	12.4
12/20/2010 to 2/15/2011	9.4	4.5
2/15/2011 to 3/2/2011	-1.0	-1.0
3/2/2011 to 3/8/2011	1.2	0.8
3/8/2011 to 3/22/2011	-1.8	-2.6
3/22/2011 to 7/12/2011	5.5	-2.4
7/12/2011 to 9/28/2011	-0.6	2.2

About half of the water level rise in MW 3 occurred during the initial three weeks for the 2011 water year. Cumulative water level changes in MW 2 and MW 3 were similar for the water year, with MW 2 having a total rise of 15.8 feet, and MW 3 rising 14.1 feet.

Ranch Well 17

As mentioned in prior monitoring reports, Ranch Well 17 hasn't been used for irrigation since October 2007. The well is located approximately 1,200 feet from recovery wells 3 and 4. The well casing is perforated between 150 and 390 feet in depth. During the winter of 2007-2008 this well was converted to be used as an observation well, and a pressure transducer was installed to take frequent depth-to-water readings. **Figure 3-4** is the 2011 WY water level hydrograph for Ranch Well 17. Project recharge operations, contributed to the overall water level rise in the well of 23.8 feet during the water year. The influence of irrigation well pumping during April through September can be seen (the small temporary drawdowns).

In preparation of the construction of the nested monitor wells, **Figure 3-5** is included for nested well system B. Hydrographs depicting the elevation of the piezometric water level for MW 1, MW 3 and Ranch Well #17 are shown on the figure.

3.1.2 Water-Level Measurements for Off-Site Wells

TeVelde Wells

As mentioned in the 2007 GMP Report, Mr. David TeVelde allowed the District access to the wells on his ranch (southeast of the Project) for the purpose of groundwater monitoring. Two of these wells that are unused are equipped with

pressure transducers to provide more frequent measurement of changes during the water year. The information gathered during the 2011 WY from these wells indicates that water levels continued to steadily rise throughout the year. These wells are located east and southeast of the Project.

Other Wells

Kings River supplies were roughly 170% of average this year, however, many local growers who do not receive surface water deliveries, were still forced to rely heavily on groundwater pumpage in order to meet their irrigation demand. See the Apex Ranch – Groundwater Monitoring Table for WY 2011 in **Appendix B** for a comparison of on and offsite groundwater wells from fall of 2010 to fall of 2011. Further, water levels in wells along the Old River downstream of the Project have water levels that have increase significantly; some as much as 37 feet.

Water Elevation Mapping

As a continuation of the water elevation mapping that was prepared in the 2009 report, this year there were four maps prepared. These maps, as listed below, can be found as **Plates 5, 6, 7 and 8** respectively.

- April 5, 2011 (During the major recharge operations, prior to significant local groundwater pumping)
- June 3, 2011 (During the major recharge operations, prior to heavy local groundwater pumping)
- August 3, 2011 (Following the major recharge operations)
- September 28, 2011 (End of water year readings)

These maps confirm that the influence of the Apex Ranch recharge operations is very positive, for the shallow and intermediate groundwater zones.

In continuation of the request made in 2010 by the Project's monitoring committee, maps indicating depth to water levels for both spring and Fall periods were prepared (**Plates 9 and 10**). Of note is the significant change in depth to groundwater in the Fall 2011 mapping along the Old River.

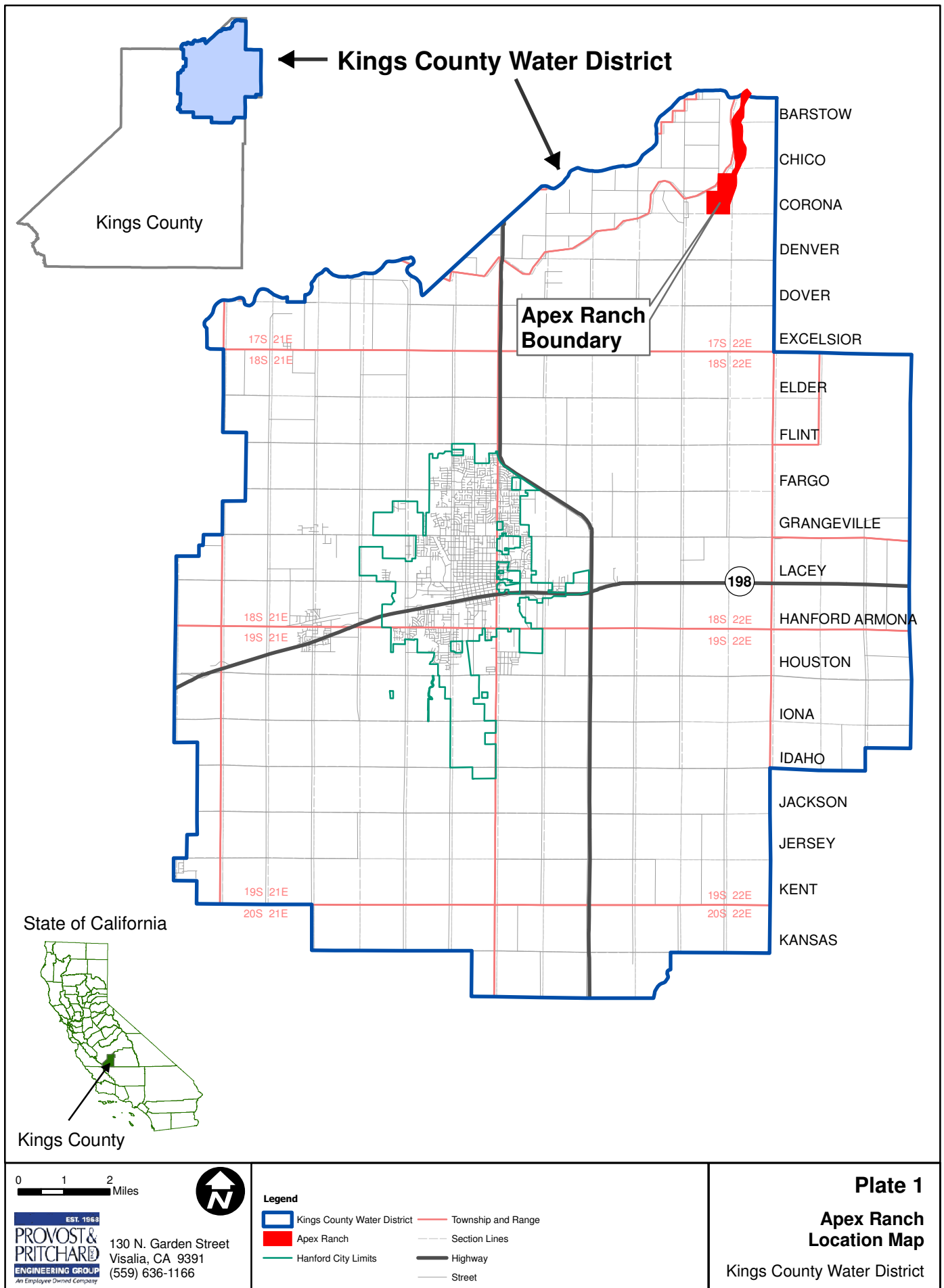
3.1.3 Well Points

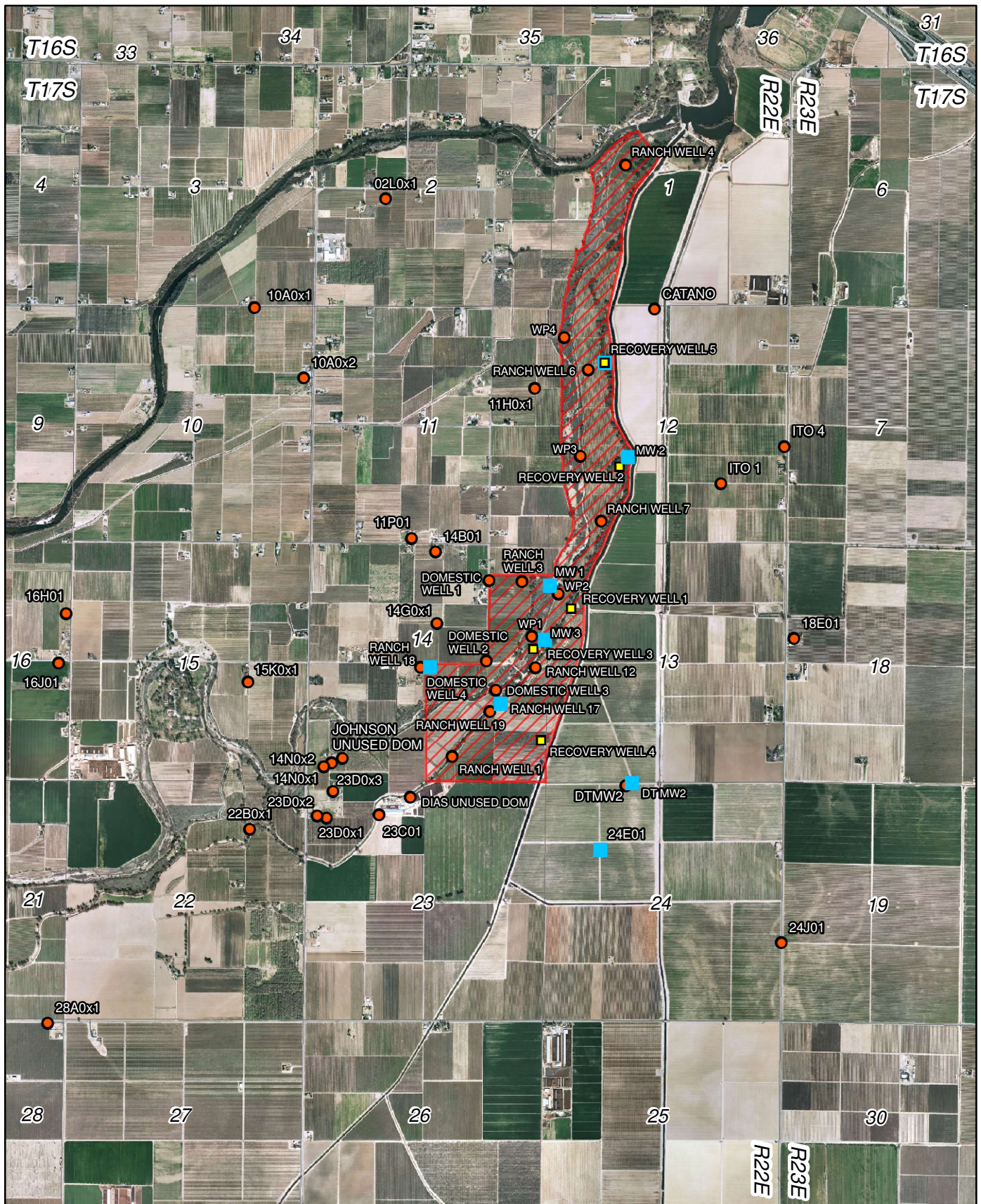
The onsite Well Points were monitored in conjunction with the onsite wells during the 2011 water year. In general, the water levels in the well points reflect the shallow conditions near the Old River Channel. Since the installation of the well points in 2005, water has only been recorded in the well points when Project recharge operations are being conducted. Measurements were recorded throughout the recharge efforts. It is important to note that no adverse affects were noted to the Ranch's crops or to nearby crops due to recharge operations.

3.2. Water Quality Monitoring

Water Quality Monitoring was not performed during the 2011, due to recovery operations not occurring. The results through water year 2009 have been included in **Appendix D**.

PLATES





0 0.25 0.5 Miles



EST. 1993
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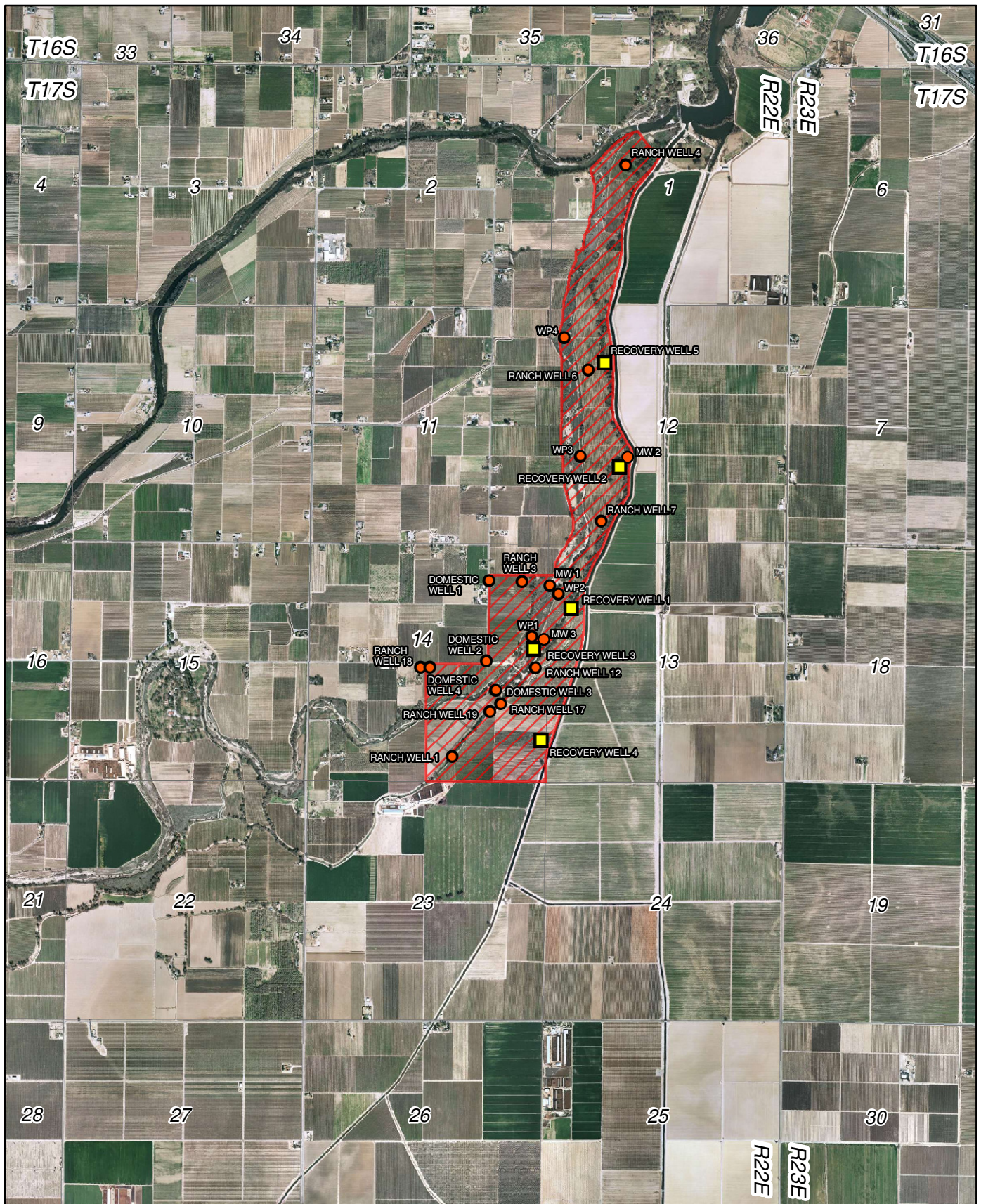
Legend

- Well Location
- Recovery Well Location
- Data Logger Location
- ▨ Apex Ranch Project Area

KCWD Apex Ranch Conjunctive Use Project

2011 Location of All Measured Wells

PLATE 2



0 0.25 0.5
Miles



EST. 1953
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

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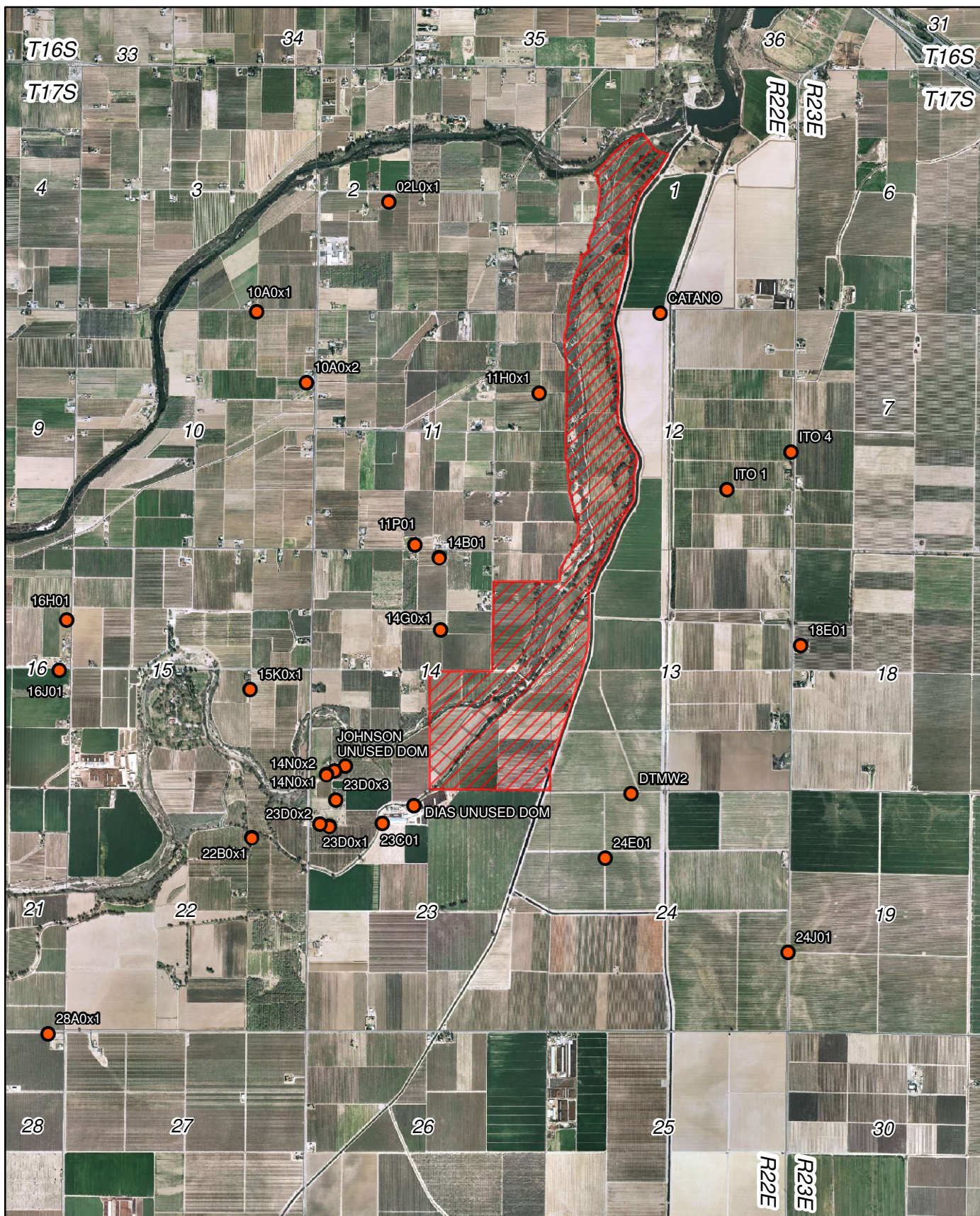
Legend

- Well Location
- Recovery Well Location
- Apex Ranch Project Area

KCWD Apex Ranch Conjunctive Use Project

2011 Location of Onsite Wells
in Monitoring Network

PLATE 3



0 0.25 0.5
Miles



EST. 1953
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

**Kenneth D. Schmidt
& Associates**

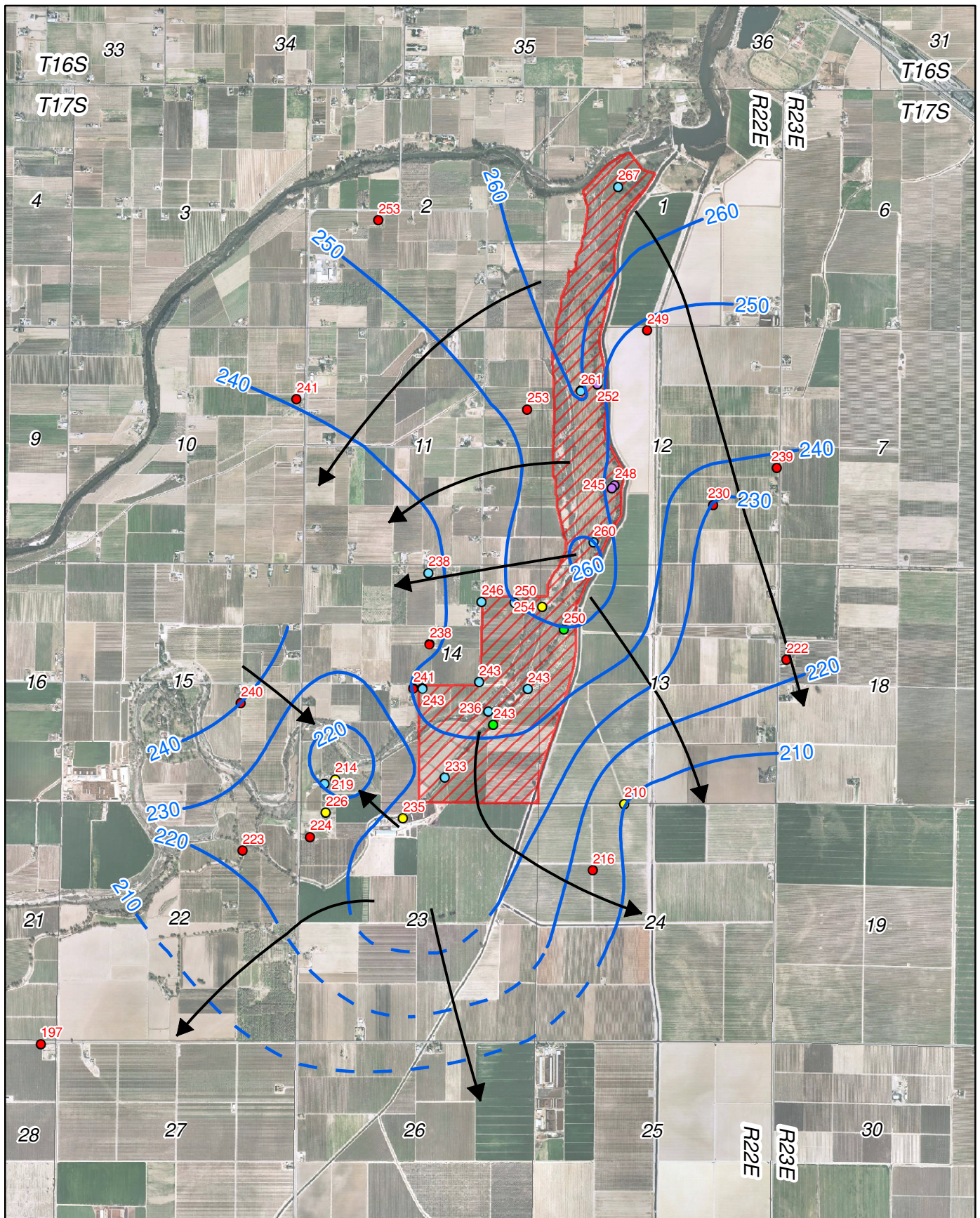
Legend

- Well Location
- Apex Ranch Project Area

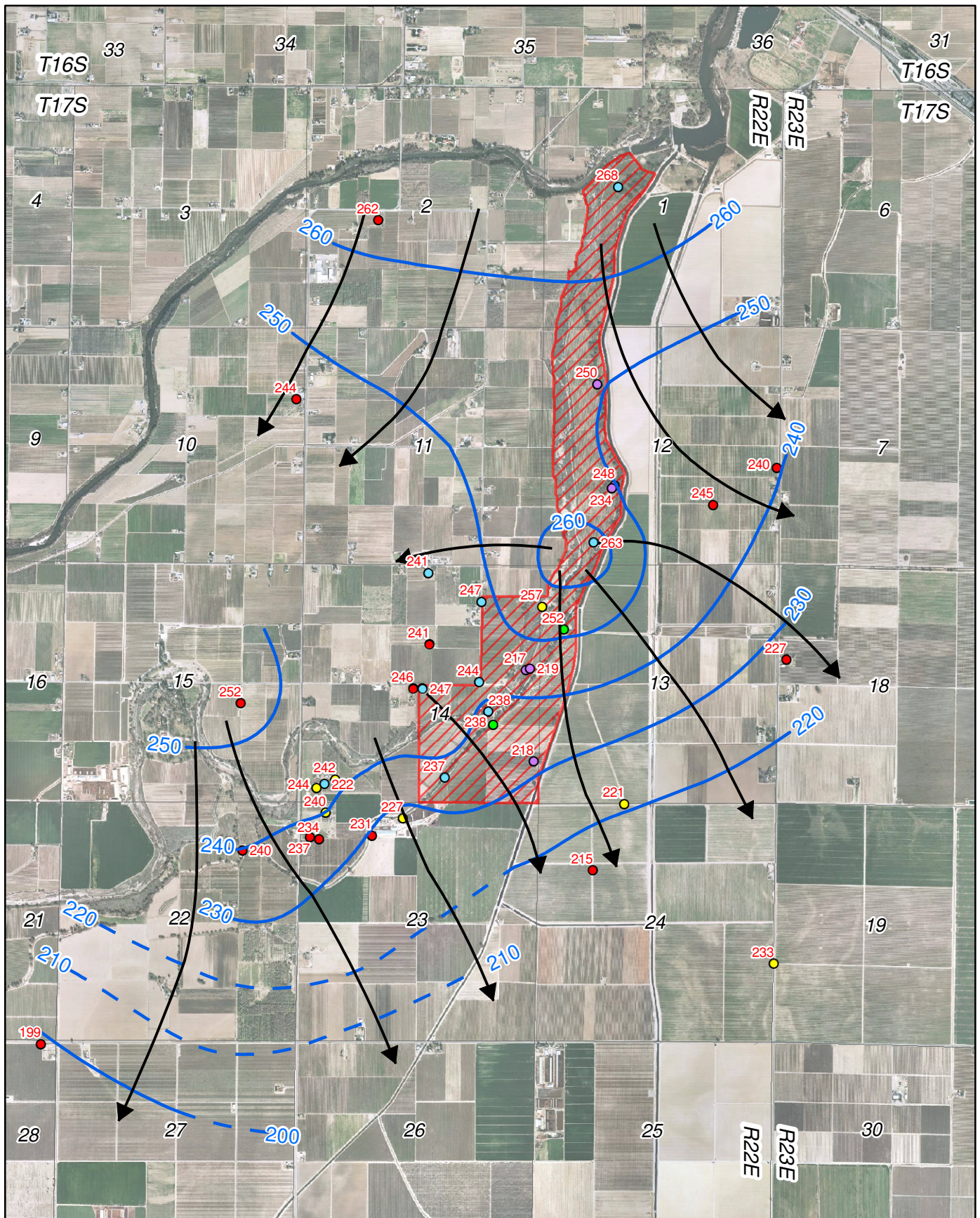
KCWD Apex Ranch Conjunctive Use Project

2011 Location of Offsite Wells
in Monitoring Network

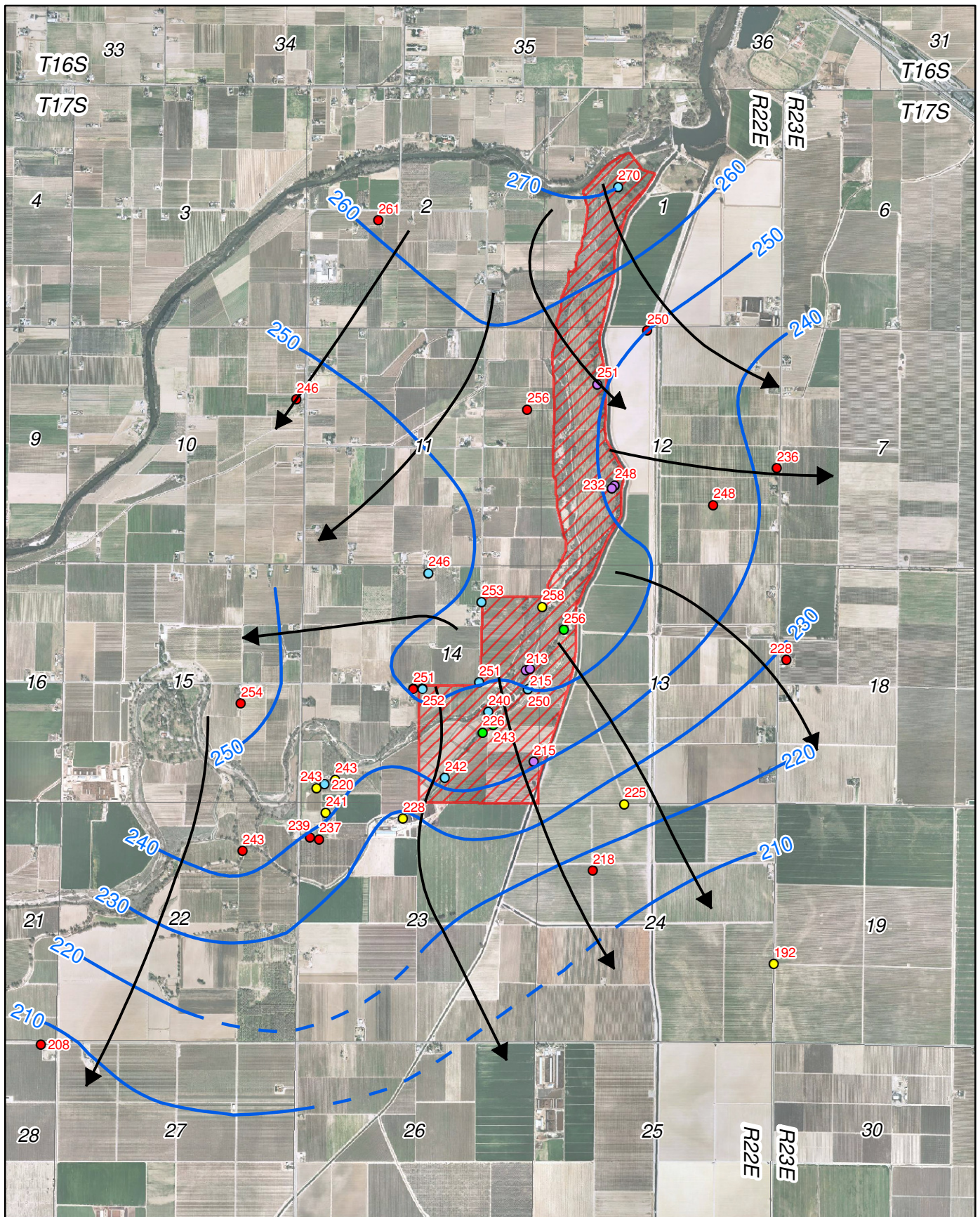
PLATE 4



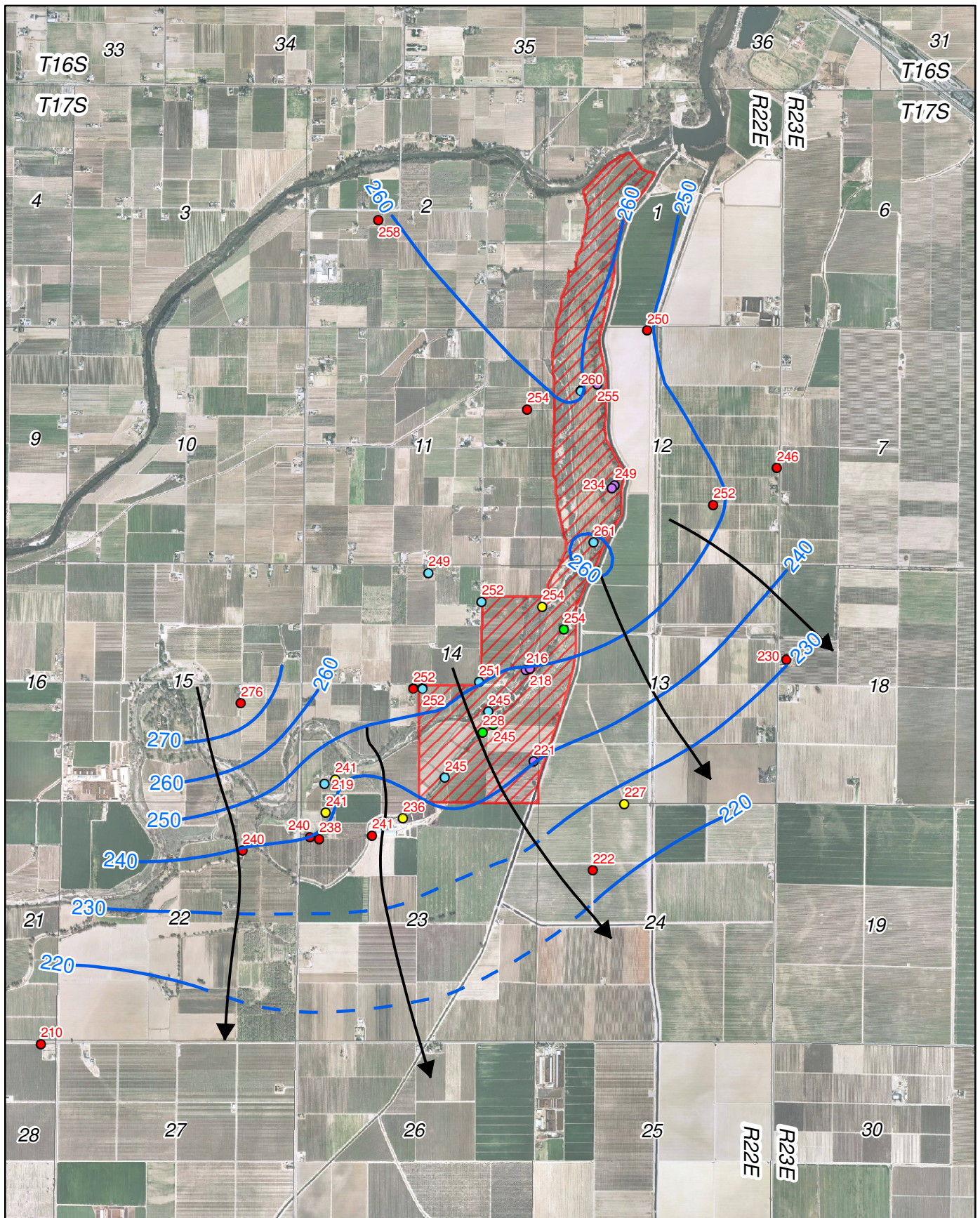
<p>0 1,000 2,000 Feet</p> <p>PROVOST & PRITCHARD EST. 1958 CONSULTING GROUP An Employee Owned Company</p> <p>Kenneth D. Schmidt & Associates</p>	<p>Legend</p> <ul style="list-style-type: none"> Apex Ranch Project Area Water Level Elevation Contour (feet) Groundwater Flow Direction <p>Well and Water Level Elevation (Feet) Total Well Depth (ft)</p> <ul style="list-style-type: none"> < 125' 125' to 225' 225' to 500' > 500' Unknown Depth 	<p>KCWD Apex Ranch Conjunctive Use Project April 5, 2011 Water Level Elevation and Groundwater Flow Direction PLATE 5</p>
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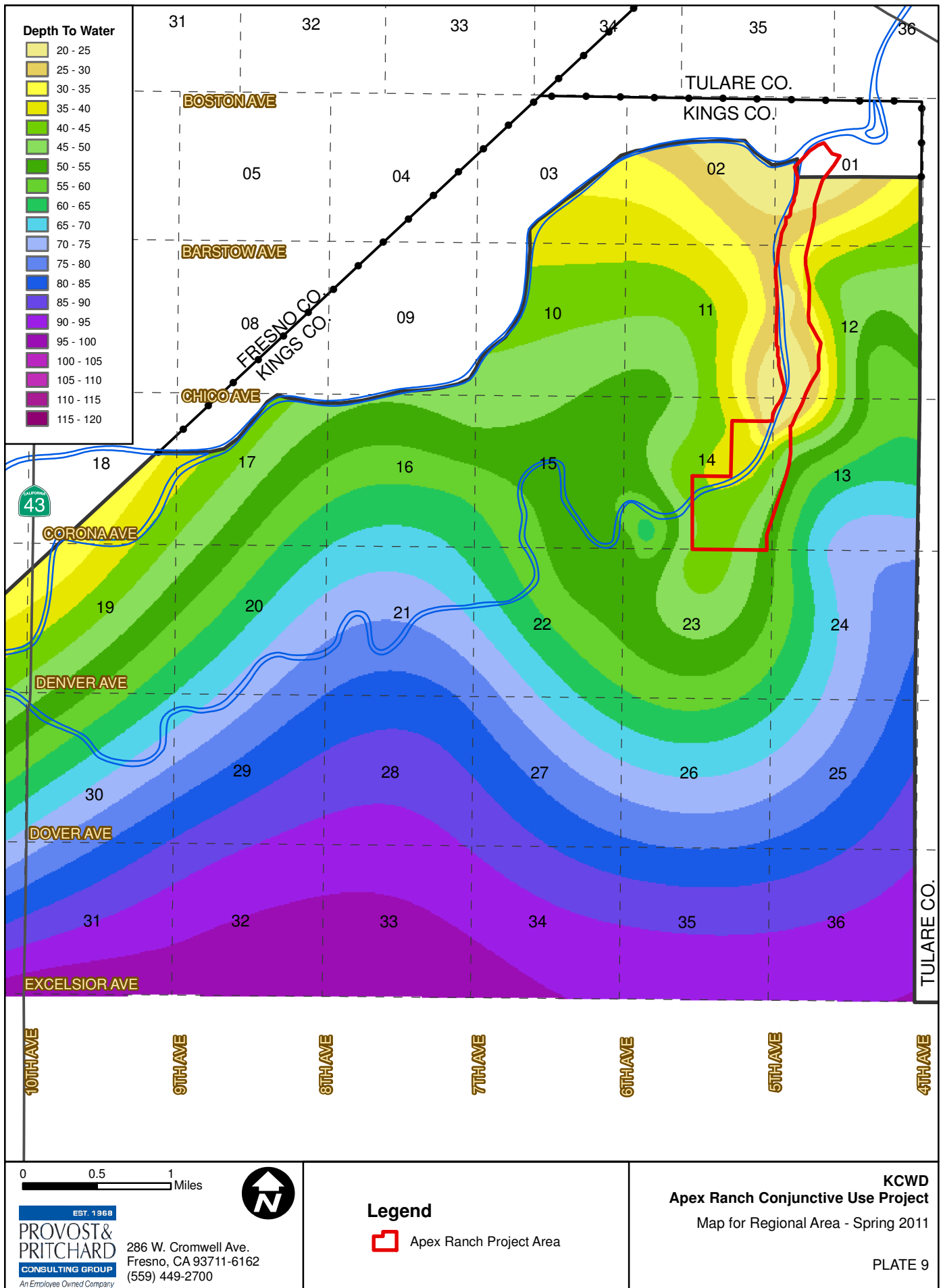
<p>0 1,000 2,000 Feet</p> <p>PROVOST & PRITCHARD CONSULTING GROUP <small>An Employee Owned Company</small></p> <p>Kenneth D. Schmidt & Associates</p>	<p>Legend</p> <p> Apex Ranch Project Area</p> <p> Water Level Elevation Contour (feet)</p> <p> Groundwater Flow Direction</p> <p>Well and Water Level Elevation (Feet)</p> <p>Total Well Depth (ft)</p> <ul style="list-style-type: none"> < 125' 125' to 225' 225' to 500' > 500' Unknown Depth 	<p>KCWD</p> <p>Apex Ranch Conjunctive Use Project</p> <p>June 3, 2011</p> <p>Water Level Elevation and Groundwater Flow Direction</p> <p>PLATE 6</p>
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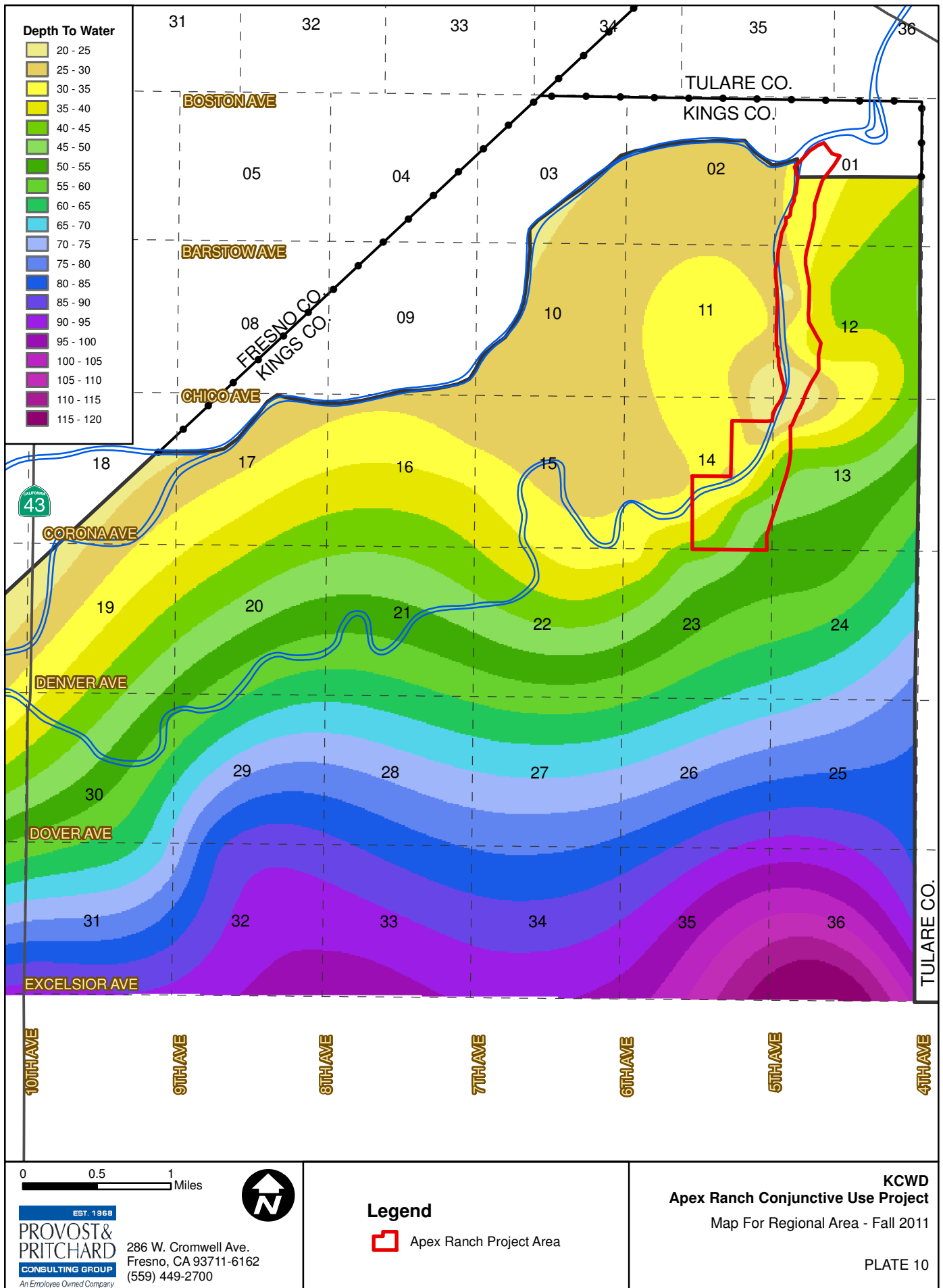


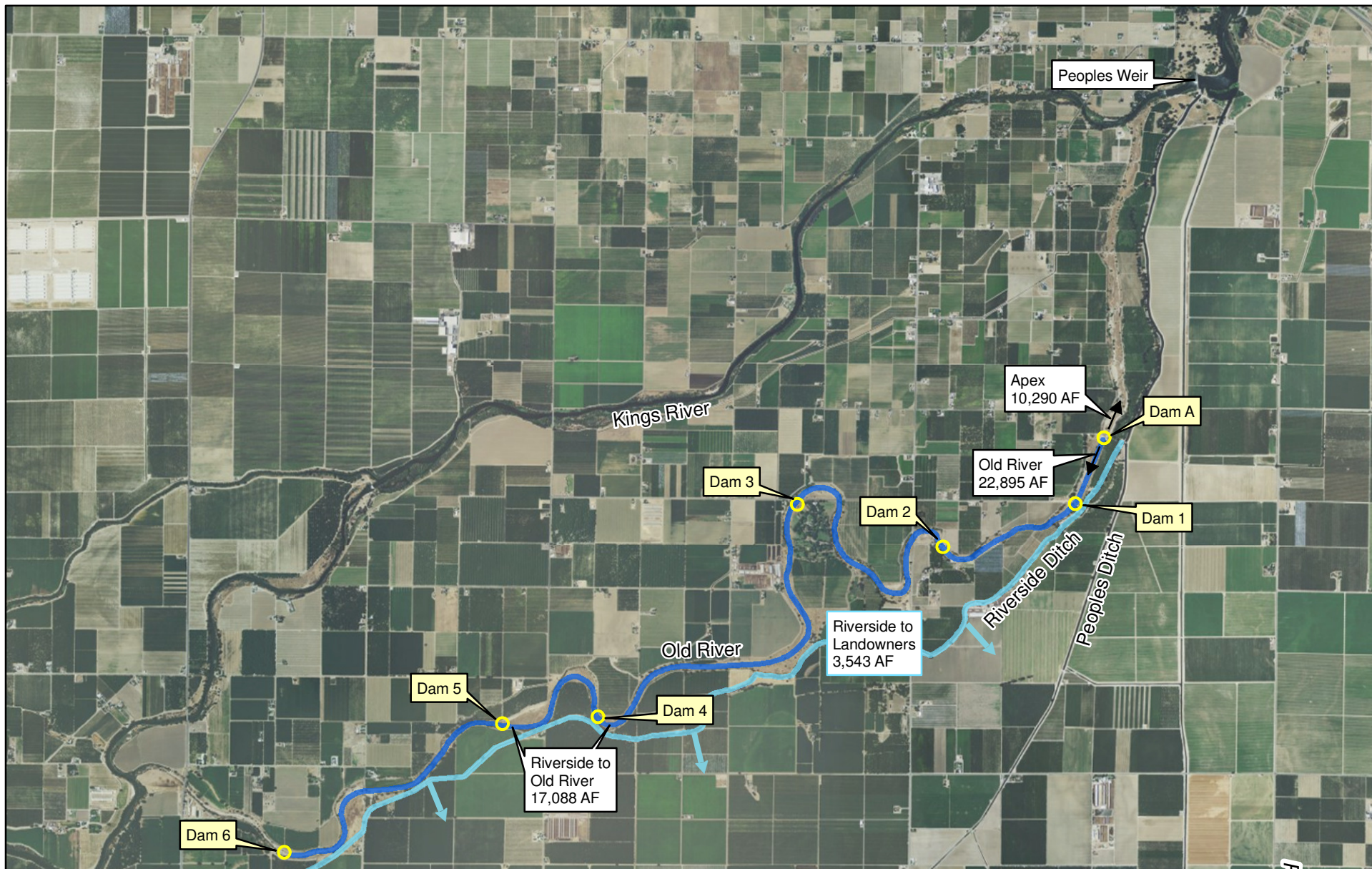
<p>0 1,000 2,000 Feet</p> <p>EST. 1958 PROVOST & PRITCHARD CONSULTING GROUP An Employee Owned Company</p> <p>Kenneth D. Schmidt & Associates</p>	<p>Legend</p> <ul style="list-style-type: none"> Apex Ranch Project Area Water Level Elevation Contour (feet) Groundwater Flow Direction <p>Well and Water Level Elevation (Feet)</p> <p>Total Well Depth (ft)</p> <ul style="list-style-type: none"> < 125' 125' to 225' 225' to 500' > 500' Unknown Depth 	<p>KCWD Apex Ranch Conjunctive Use Project</p> <p>August 3, 2011 Water Level Elevation and Groundwater Flow Direction</p> <p>PLATE 7</p>
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<p>0 1,000 2,000 Feet</p> <p>PROVOST & PRITCHARD EST. 1958 CONSULTING GROUP An Employee Owned Company</p> <p>Kenneth D. Schmidt & Associates</p>	<p>Legend</p> <ul style="list-style-type: none"> Apex Ranch Project Area — Water Level Elevation Contour (feet) → Groundwater Flow Direction <p>Well and Water Level Elevation (Feet)</p> <p>Total Well Depth (ft)</p> <ul style="list-style-type: none"> ● < 125' ● 125' to 225' ● 225' to 500' ● > 500' ● Unknown Depth 	<p>KCWD Apex Ranch Conjunctive Use Project September 28, 2011 Water Level Elevation and Groundwater Flow Direction</p> <p>PLATE 8</p>
---	--	--







0 0.5 1
Miles

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700

Legend

Reach of Old River Recharge

KCWD
Apex Ranch Conjunctive Use Project
2011 Old River Flood Water Deliveries

PLATE 11

APPENDIX A

Summary of WY 2011 Recharge and Recovery Operations

KINGS RIVER FLOOD WATER DELIVERIES

Kings County Water District - Old River & Riverside Water Diversions

Water Year	Kings River % Water per Year	Old River			Riverside		Apex	Total Water Diverted
		Condition 8 Required	Condition 8 Actual	Water Delivered into Old River Below Dam A	Water Delivered to Landowners	Water Delivered to Old River via Riverside ¹	Apex Ranch Project Recharge ²	
		(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
2002	67.0%	0	0	0	0	0	225	225
2003	83.0%	0	0	0	0	0	3,742	3,742
2004	61.0%	0	0	0	0	0	0	0
2005	148.0%	4,349	5,442	0	2,633	1,861	10,994	20,930
2006	172.0%	7,209	22,612	0	6,306	5,139	12,152	46,209
2007	39.0%	0	0	0	0	0	3,630	3,630
2008	74.0%	829	0	0	0	0	2,792	2,792
2009	79.0%	829	0	1,188	0	0	9,514	10,702
2010	121.0%	0	0	267	114	5,138	9,154	14,673
2011	170.0%	6,000 ³	22,895	0	3,543	17,088	10,290	53,816
Subtotals		19,218	50,949	1,455	12,596	29,226	62,493	156,719
Totals			52,404		41,822			
Average	101.4%	1,922	5,095	146	1,260	2,923	6,249	15,672

¹ From 2002 to 2009, the District did not make deliveries the the Old River through Riverside

² For a more detailed summary of Apex Ranch operations refer to the Apex Yearly Banking Summary

³ The required 2011 Condition 8 volume is an estimate from Kings County Water District

APEX RANCH

Water Banking Summary

Water Year	Kings River % Water per Year	Apex Ranch Project Recharge	Losses ¹	Water Available from Storage ²	Water Recovered	End of Year Recharged Water in Storage
			(10%) <i>Dedicated Leave Behind</i> ³			
		(AF)	(AF)	(AF)	(AF)	(AF)
2002	67.0%	225	23	202	0	202
2003	83.0%	3,742	374	3,570	526	3,044
2004	61.0%	0	0	3,044	912	2,132
2005	148.0%	10,994	1,100	12,026	0	12,026
2006	172.0%	12,152	1,214	22,964	6,939	16,025
2007	39.0%	3,630	363	19,292	6,319	12,973
2008	74.0%	2,792	280	15,485	5,435	10,050
2009	79.0%	9,514	952	18,612	7,677	10,935
2010	121.0%	9,154	2,747	17,342	6,345	10,997
2011	170.0%	10,290	1,028	20,259	0	20,259
Totals		62,493	8,081		34,153	
Average	101.4%	6,249	808	13,280	3,415	9,864

¹ Losses: Water that has been dedicated to the local Project area in addition to amount delivered to the Old River Downstream from Apex Ranch.

² Water Available from Storage is calculated with the 10% dedicated leave-behind already accounted for

³ KCWD agreed with KRAPOA to Leave 30% for the 2010 Water Year

APEX RANCH

Water Banking Summary : Recharge

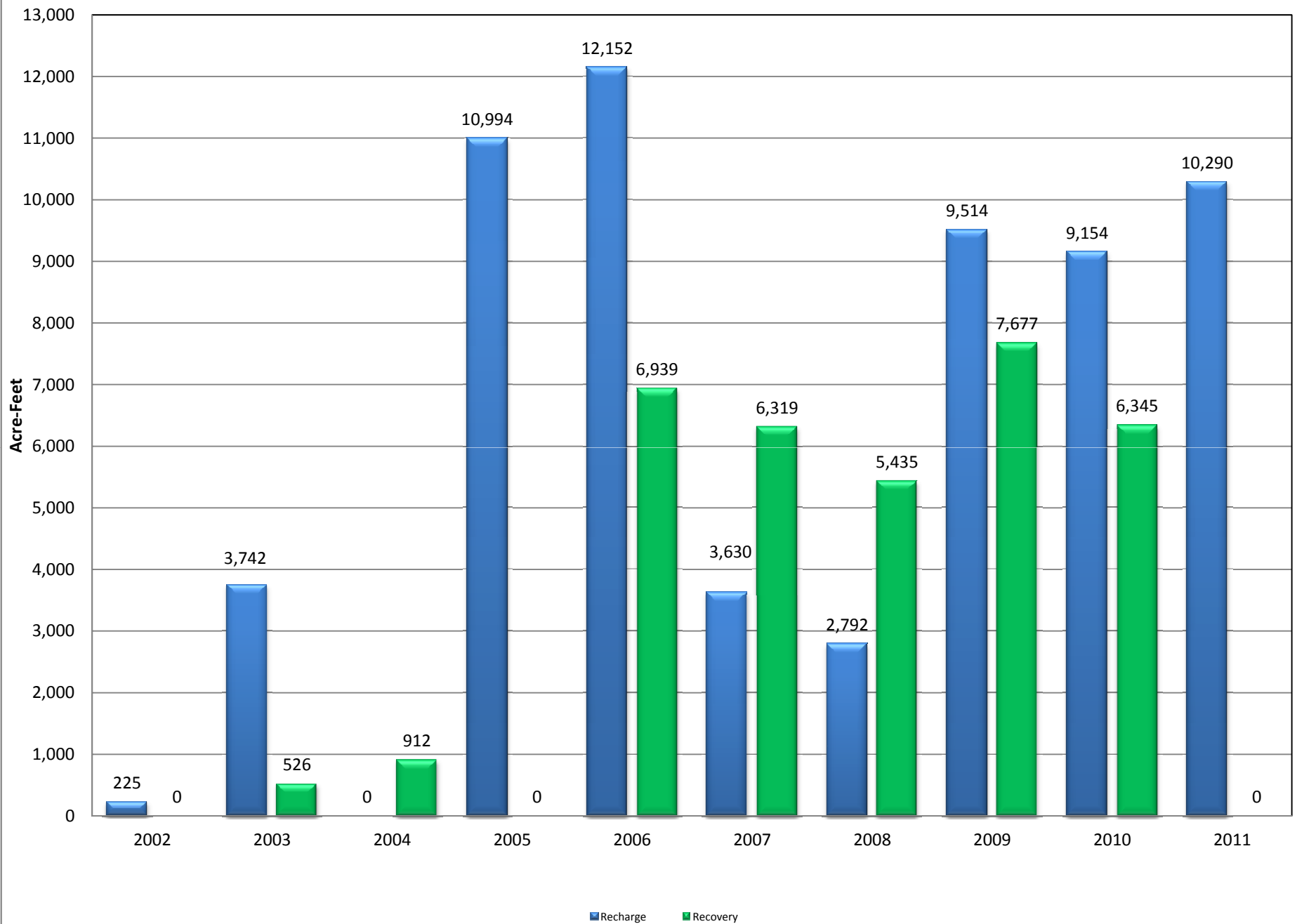
Water Year	Oct. (AF)	Nov. (AF)	Dec. (AF)	Jan. (AF)	Feb. (AF)	Mar (AF)	Apr. (AF)	May (AF)	June (AF)	July (AF)	Aug. (AF)	Sept. (AF)	Annual (AF)
2002	0	0	0	0	0	0	0	0	0	21	204	0	225
2003	0	2,320	0	0	0	0	0	0	1,422	0	0	0	3,742
2004	0	0	0	0	0	0	0	0	0	0	0	0	0
2005	0	518	666	695	1,697	61	2,465	2,636	2,256	0	0	0	10,994
2006	0	2,063	1,429	1,746	0	0	2,653	2,459	1,785	17	0	0	12,152
2007	0	1,682	1,020	928	0	0	0	0	0	0	0	0	3,630
2008	1,171	1,236	0	0	0	0	0	0	0	0	385	0	2,792
2009	820	4,099	957	1,308	1,509	821	0	0	0	0	0	0	9,514
2010	893	357	1,568	2,571	1,869	552	336	1,008	0	0	0	0	9,154
2011	0	0	843	2,222	883	1,246	2,202	1,646	1,012	238	0	0	10,290
Totals	2,884	30,550	6,483	9,470	5,958	2,680	7,656	7,749	6,475	276	589	0	62,493
Average	288	2,777	648	947	596	268	766	775	647	28	59	0	6,249

APEX RANCH

Water Banking Summary : Recovery

Water Year	Oct. (AF)	Nov. (AF)	Dec. (AF)	Jan. (AF)	Feb. (AF)	Mar (AF)	Apr. (AF)	May (AF)	June (AF)	July (AF)	Aug. (AF)	Sept. (AF)	Annual (AF)
2002	0	0	0	0	0	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0	0	286	240	0	526
2004	0	0	0	0	0	0	0	0	138	428	346	0	912
2005	0	0	0	0	0	0	0	0	0	0	0	0	0
2006	0	0	0	58	1,637	1,590	0	0	0	1,276	1,798	580	6,939
2007	0	0	0	0	892	178	0	375	1,607	1,660	1,607	0	6,319
2008	0	0	0	0	0	0	0	847	2,118	2,188	282	0	5,435
2009	0	0	0	0	578	0	0	0	2,638	2,735	1,726	0	7,677
2010	0	0	0	0	0	0	0	0	276	2,857	2,516	696	6,345
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	0	6,000	0	58	3,107	1,768	0	1,222	6,777	11,430	8,515	1,276	34,153
Average	0	545	0	6	311	177	0	122	678	1,143	852	128	3,415

APEX RANCH BANKING OPERATIONS



APPENDIX B

WY 2011 Monitoring Results (Field Data and Hydrographs)

KINGS COUNTY WATER DISTRICT
APEX RANCH - WATER LEVEL MONITORING RESULTS
2011 Water Year

P & P Well Name	Depth to Water (FT)					Change in Depth (FT)				
	Beginning WY 2010 9/20/2010	Early Spring WY 2011 4/5/2011	Late Spring WY 2011 6/3/2010	Summer WY 2011 8/3/2011	End of WY 2011 9/28/2011	9/20/2010 to 4/5/2011	4/5/2011 to 6/3/2011	6/3/2011 to 8/3/2011	8/3/2011 to 9/28/2011	9/20/2010 to 9/28/2011
RECOVERY WELLS										
Recovery Well 1	54.1	40.2	38.6	34.2	35.9	13.9	1.6	4.4	-1.7	18.2
Recovery Well 2	66.2	39.5	51.2	53.3	50.5	26.7	-11.7	-2.1	2.8	15.7
Recovery Well 3	80.8	59.9	63.4	67.9	64.6	20.9	-3.5	-4.5	3.3	16.2
Recovery Well 4	82.7	63.2	66.5	68.8	63.3	19.5	-3.3	-2.3	5.5	19.4
Recovery Well 5	48.9	35.1	37.0	36.6	32.9	13.8	-1.9	0.4	3.7	16.0
ONSITE WELLS										
MW 1	39.5	23.2	20.1	19.2	23.4	16.3	3.1	0.9	-4.2	16.1
MW 2	52.2	37.2	37.3	37.6	36.2	15.0	-0.1	-0.3	1.4	16.0
MW 3	77.1	57.0	60.9	64.9	61.6	20.1	-3.9	-4.0	3.3	15.5
Ranch Well 1	PR	50.6	46.9	41.8	39.2	--	3.7	5.1	2.6	--
Ranch Well 3	PR	33.1	PR	PR	PR	--	--	--	--	--
Ranch Well 4	19.7	16.8	15.9	14.1	PR	2.9	0.9	1.8	--	--
Ranch Well 6	PR	24.7	PR	PR	25.2	--	--	--	--	--
Ranch Well 7	34.9	21.4	18.7	PR	20.2	13.5	2.7	--	--	14.7
Ranch Well 12	PR	42.5	PR	35.5	PR	--	--	--	--	--
Ranch Well 17	63.9	42.7	47.5	42.1	40.2	21.2	-4.8	5.4	1.9	23.7
Ranch Well 18	55.8	40.8	35.3	30.8	29.8	15.0	5.5	4.5	1.0	26.0
Ranch Well 19	76.2	59.3	--	60.3	57.6	16.9	--	--	2.7	18.6
Domestic Well 1	52.8	39.0	38.1	32.6	32.8	13.8	0.9	5.5	-0.2	20.0
Domestic Well 2	52.1	37.0	36.5	29.0	29.6	15.1	0.5	7.5	-0.6	22.5
Domestic Well 3	56.3	41.8	39.8	37.9	33.2	14.5	2.0	1.9	4.7	23.1
Domestic Well 4	57.4	40.9	36.5	32.0	31.5	16.5	4.4	4.5	0.5	25.9
OFFSITE WELLS										
17S22E14B01	52.0	44.5	41.0	36.5	33.0	7.5	3.5	4.5	3.5	19.0
17S22E23D0x1	--	53.5	40.0	37.8	37.0	--	13.5	2.2	0.8	--
17S22E23D0x3	71.0	49.0	35.0	33.8	34.0	22.0	14.0	1.2	-0.2	37.0
Johnston Unused	72.0	45.4	33.5	31.6	34.0	26.6	11.9	1.9	-2.4	38.0
Dias Unused	71.5	61.5	52.6	51.5	44.0	10.0	8.9	1.1	7.5	27.5
17S23E18E01	65.2	61.0	57.0	55.5	53.5	4.2	4.0	1.5	2.0	11.7
17S22E02L0x1	34.0	31.9	22.6	24.0	26.5	2.1	9.3	-1.4	-2.5	7.5
17S22E10A0x2	--	42.8	40.5	37.5	PR	--	2.3	3.0	--	--
17S22E11H0x1	46.0	32.0	PR	29.0	31.0	14.0	--	--	-2.0	15.0
17S22E14G0x1	PR	42.0	39.0	PR	PR	--	3.0	--	--	--
17S22E14N0x1	69.0	PR	31.0	32.0	PR	--	--	-1.0	--	--
17S22E14N0x2	78.0	56.1	53.0	54.5	56.0	21.9	3.1	-1.5	-1.5	22.0
17S22E15K0x1	59.0	35.4	23.5	22.0	--	23.6	11.9	1.5	--	--
17S22E22B01	74.2	53.0	36.2	33.0	36.5	21.2	16.8	3.2	-3.5	37.7
17S22E23C01	65.3	PR	49.0	PR	39.3	--	--	--	--	26.0
17S22E23D0x2	PR	PR	41.0	38.0	37.0	--	--	3.0	1.0	--
17S22E24E01 (DT12)	67.3	62.0	62.1	59.4	55.4	5.3	-0.1	2.7	4.0	11.9
17S22E24J01 (DT20)	PR	--	44.8	86.0	PR	--	--	-41.2	--	--
17S22E28A0x1	92.5	76.4	74.0	65.2	63.5	16.1	2.4	8.8	1.7	29.0
DT MW 2	--	68.8	58.1	54.3	51.6	--	10.7	3.8	2.7	--
ITO 1	PR	57.4	42.0	39.0	35.2	--	15.4	3.0	3.8	--
ITO 4	PR	50.6	49.7	53.9	44.0	--	0.9	-4.2	9.9	--
Catano Well	49.8	39.4	PR	38.0	38.0	10.4	--	--	0.0	11.8
ANNUAL DWR WELLS										
DWR Well Name	Fall 2010 10/9/10	Spring 2011 2/18/11		Fall 2011 10/08/11	10/9/2010 to 2/18/2011	2/18/2011 to 10/8/2011				10/9/2010 to 10/8/2011
17S22E11P01	56.4	50.4		33.9	6	16.5				22.5
17S22E16J01	71.9	59.3		36	12.6	23.3				35.9
17S22E28A01	92.3	82.5		62.5	9.8	20				29.8

(-9.5) Indicates a decline in water level
(12.5) Indicates a rise in water level

Kings County Water District
APEX RANCH CONJUNCTIVE USE PROJECT

DEPTH TO WATER IN WELLS - 2011
(Values in Feet)

	RECOVERY WELLS					Monitoring Network Onsite Wells																			
DATE	Recovery Well 1 ¹	Recovery Well 2 ²	Recovery Well 3 ²	Recovery Well 4 ¹	Recovery Well 5 ¹	MW 1 ¹	MW 2 ¹	MW 3 ¹	Ranch Well 1	Ranch Well 3	Ranch Well 4	Ranch Well 6	Ranch Well 7	Ranch Well 12	Ranch Well 17 ¹	Ranch Well 18	Ranch Well 19	Domestic Well 1	Domestic Well 2	Domestic Well 3	Domestic Well 4 ¹	Well Point 1	Well Point 2	Well Point 3	Well Point 4
	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW
9/20/2010	54.1	66.2	80.8	82.7	48.9	39.5	52.2	77.1	PR	PR	19.7	PR	34.9	PR	63.9	55.8	76.2	52.8	52.1	56.3	57.4	--	--	--	--
4/5/2011	40.2	39.5	59.9	63.2	35.1	23.2	37.2	57.0	50.6	33.1	16.8	24.7	21.4	42.5	42.7	40.8	59.3	39.0	37.0	41.8	40.9	--	--	--	--
6/3/2011	38.6	51.2	63.4	66.5	37.0	20.1	37.3	60.9	46.9	PR	15.9	PR	18.7	PR	47.5	35.3	--	38.1	36.5	39.8	36.5	3.7	4.8	--	6.1
8/3/2011	34.2	53.3	67.9	68.8	36.6	19.2	37.6	64.9	41.8	PR	14.1	PR	PR	35.5	42.1	30.8	60.3	32.6	29.0	37.9	32.0	5.1	9.0	5.8	7.5
9/28/2011	35.9	50.5	64.6	63.3	32.9	23.4	36.2	61.6	39.2	PR	PR	25.2	20.2	PR	40.2	29.8	57.6	32.8	29.6	33.2	31.5	8.9	13.0	--	9.8

FALL 2010 TO FALL 2011 CHANGE 18.2 15.7 16.2 19.4 16.0 16.1 16.0 15.5 -- -- -- -- -- -- 23.7 26.0 -- 20.0 22.5 23.1 25.9 -- -- -- --

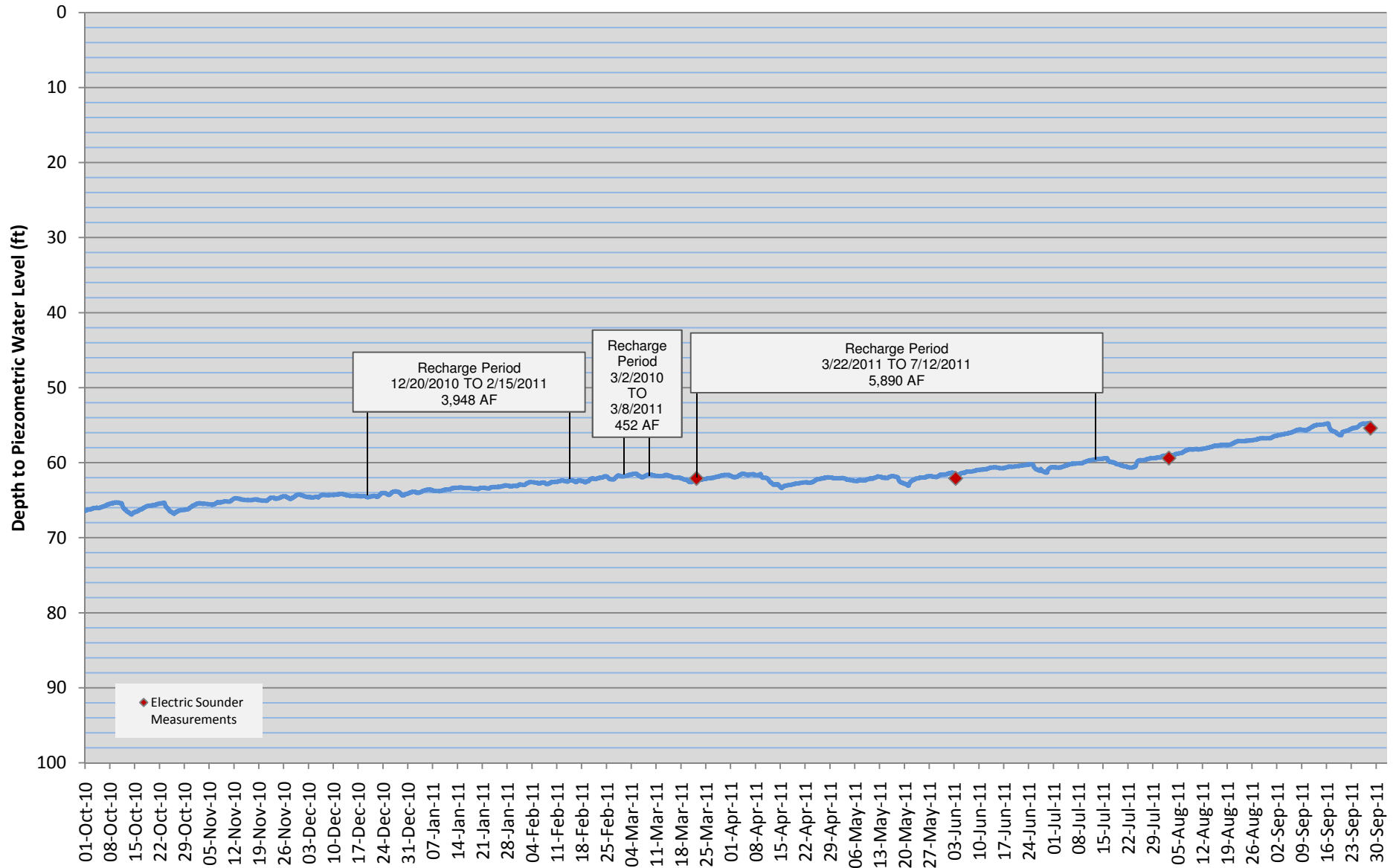
DATE	Monitoring Network Offsite Wells																						
	17S22E	17S22E	17S22E	17S22E	17S22E	17S23E	17S22E	17S22E	17S22E	17S22E	17S22E	17S22E	17S22E	17S22E	17S23E	17S22E	17S22E	17S22E	17S22E				
	14B01	23D0x1 ¹	23D0x3	Johnston Unused Domestic	Dias Unused Domestic	18E01	02L0x1	10A0x2	11H0x1	14G0x1	14N0x1	14N0x2	15K0x1	22B0x1	23C01	23D0x2	24E01 (DT12) ¹	24J01 (DT20)	28A0x1	DT MW 2 ¹	ITO 1	ITO 4	Catano Well
	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW	DTW
9/20/2010	52.0	--	71.0	72.0	71.5	65.2	34.0	BEES	46.0	PR	69.0	78.0	59.0	74.2	65.3	PR	67.3	PR	92.5	--	PR	PR	46.8
4/5/2011	44.5	53.5	49.0	45.4	61.5	61.0	31.9	42.8	32.0	42.0	PR	56.1	35.4	53.0	PR	PR	62.0	--	76.4	68.8	57.4	50.6	39.4
6/3/2011	41.0	40.0	35.0	33.5	52.6	57.0	22.6	40.5	PR	39.0	31.0	53.0	23.5	36.2	49.0	41.0	62.1	44.8	74.0	58.1	42.0	49.7	PR
8/3/2011	36.5	37.8	33.8	31.6	51.5	55.5	24.0	37.5	29.0	PR	32.0	54.5	22.0	33.0	PR	38.0	59.4	86.0	65.2	54.3	39.0	53.9	38.0
9/28/2011	33.0	37.0	34.0	34.0	44.0	53.5	26.5	PR	31.0	PR	PR	56.0	--	36.5	39.3	37.0	55.4	PR	63.5	51.6	35.2	44.0	38.0

FALL 2010 TO FALL 2011 CHANGE 19.0 -- 37.0 38.0 27.5 11.7 7.5 -- 15.0 -- -- 22.0 -- 37.7 26.0 -- 11.9 -- 29.0 -- -- -- 8.8

Notes:
¹Indicates WY 2011 Datalogger location (Recovery Well 1 was damaged; 17S22E23D0x1 was damaged)
²Indicates Measurements were taken to top of oil

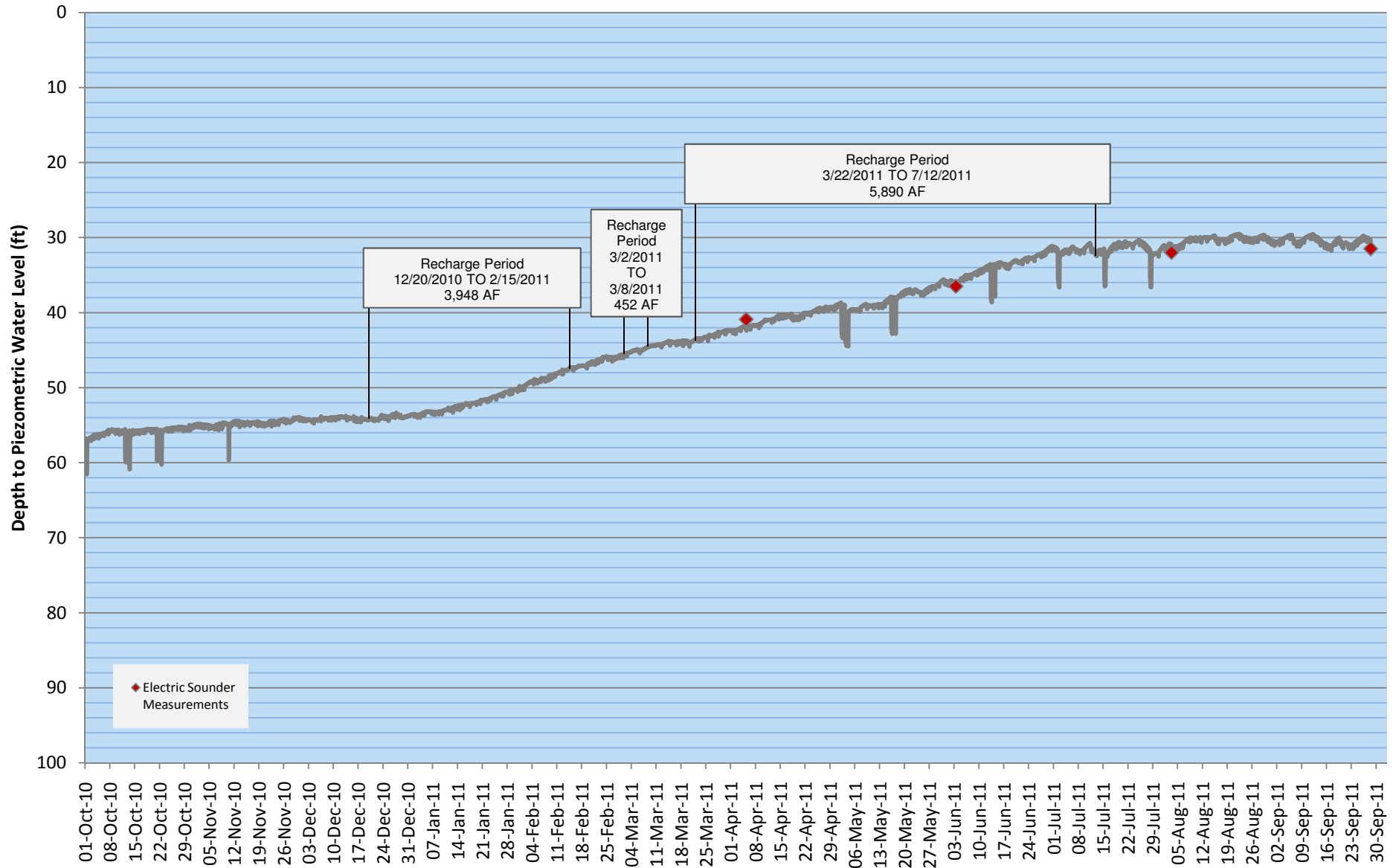
17S22E24E01 (DT12) Water Level Hydrograph

2011 Water Year



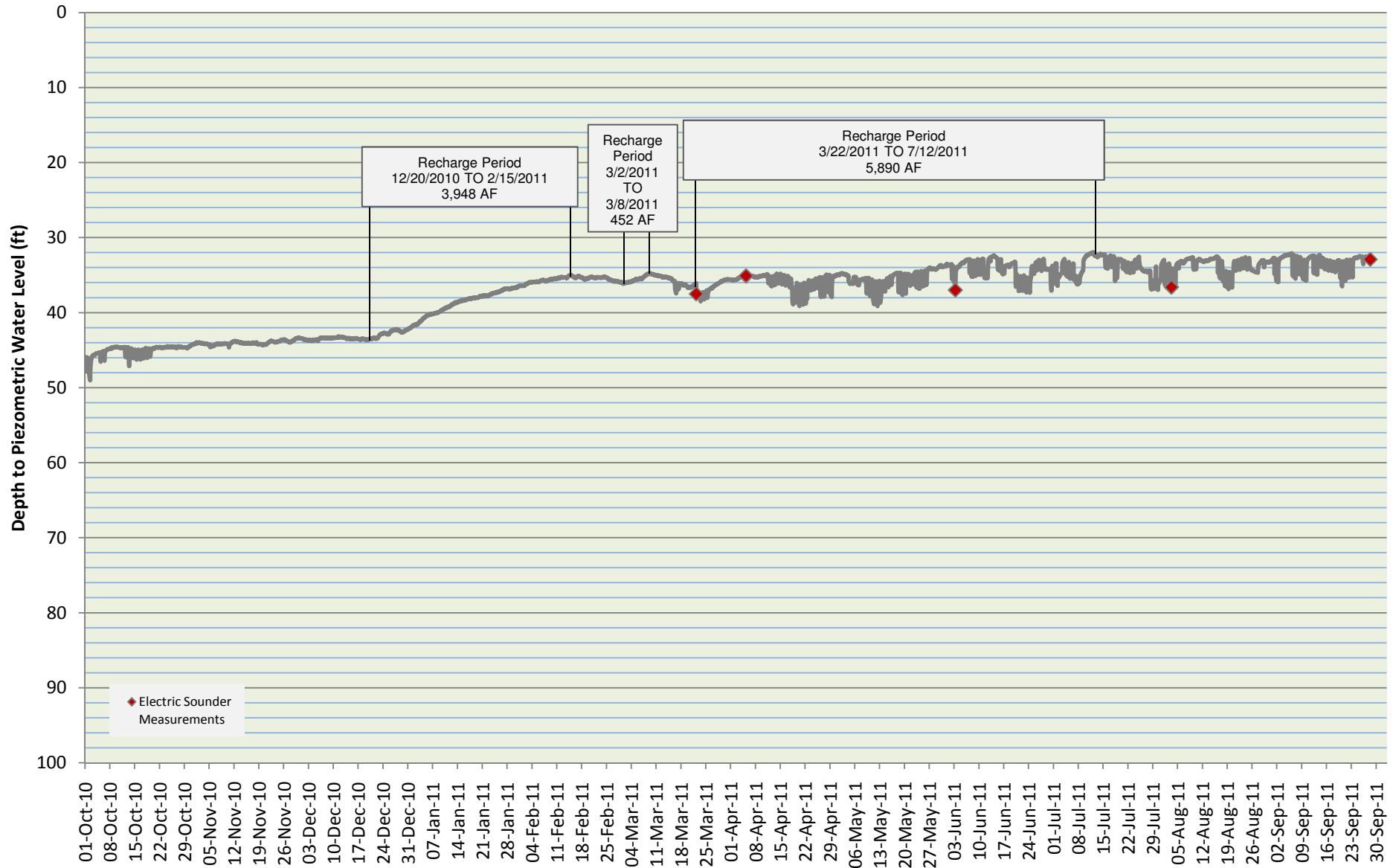
Domestic Well 4 Water Level Hydrograph

2011 Water Year



Recovery Well 5 Water Level Hydrograph

2011 Water Year

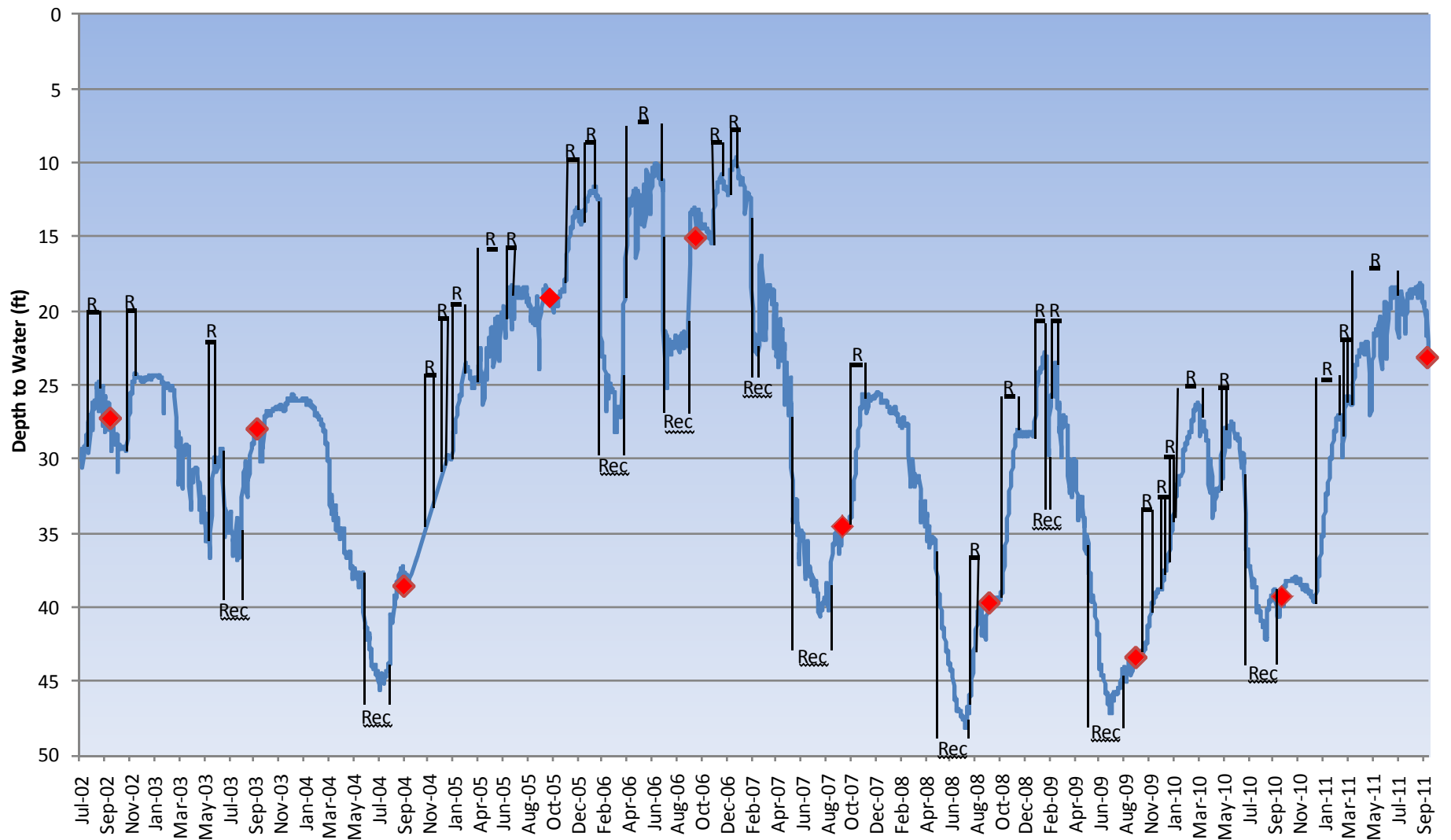


APPENDIX C

Long term Apex Ranch Project Monitor Well Hydrographs

Apex Ranch Monitor Well 1 Water Level Hydrograph

WATER YEARS 2002 - 2011



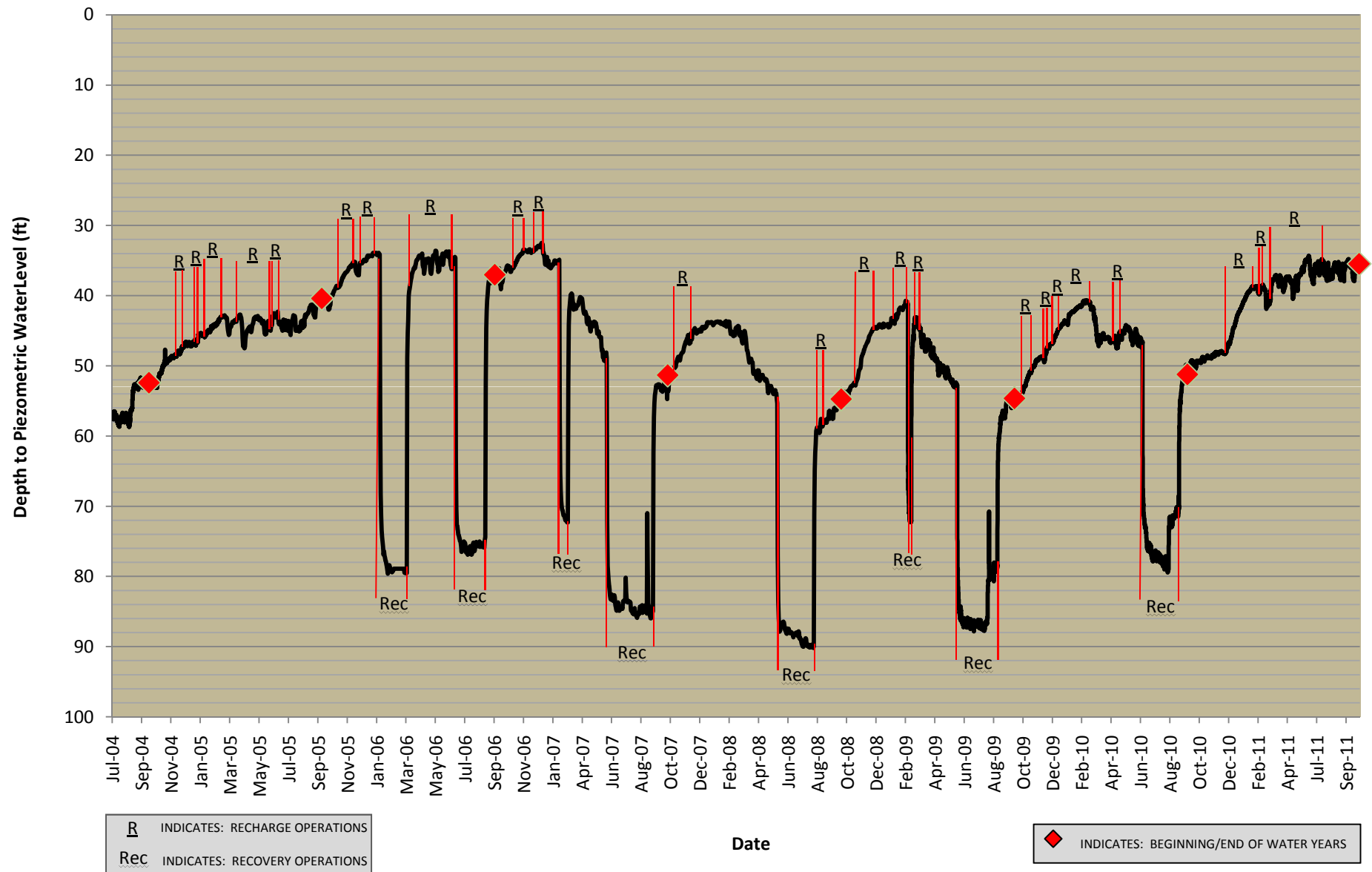
R INDICATES: RECHARGE OPERATIONS
Rec INDICATES: RECOVERY OPERATIONS

Date

◆ INDICATES: BEGINNING/END OF WATER YEARS

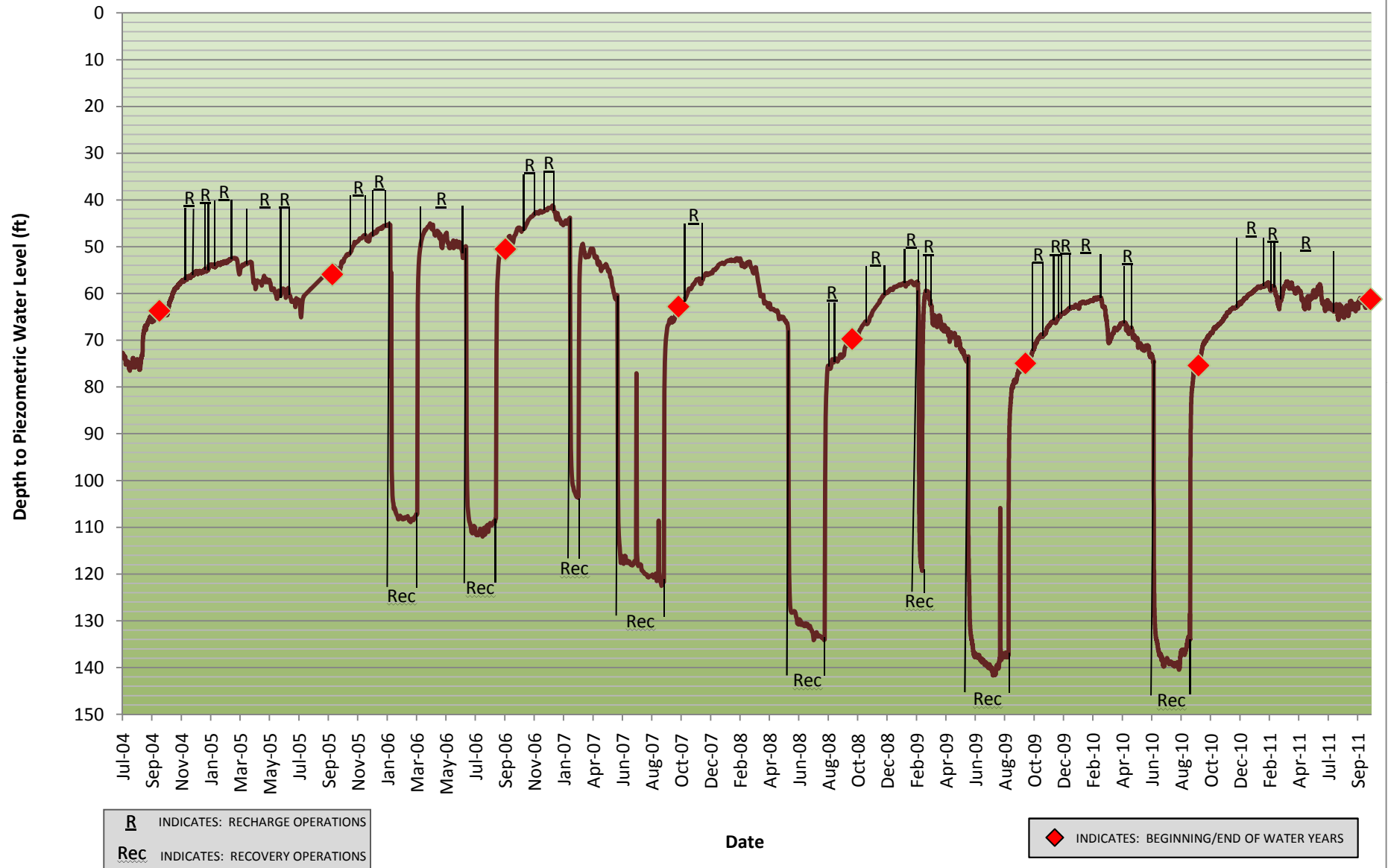
Apex Ranch Monitor Well 2 Water Level Hydrograph

WATER YEARS 2004 - 2011



Apex Ranch Monitor Well 3 Water Level Hydrograph

WATER YEARS 2004 - 2011



APPENDIX D
Water Quality Analyses

Well ID: Recovery Well #1

Sample Date	Constituent																			EC (umhos/cm) at 25°C	pH	TDS (mg/l)	Iron (mg/ml)	Manganese (mg/l)	Arsenic (ug/l)	Barium (mg/l)	Boron (mg/L)	Sulfate (mg/L)	Gross Alpha (pCi/l)	DBCP (ppb)	EDB (ppb)
	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/l)																						
7/7/2003	28	6	1	10	110	130	<10	2	0.8	230	8.1	180	<0.05	0.02	2	NT	NT	7	4.5	<0.01	<0.01										
8/8/2003	NT	NT	NT	NT	NT	NT	NT	NT	1.5	221	8.0	180	<0.05	0.02	4	NT	NT	NT	4 ??	<0.01	<0.01										
7/15/2004	NT	NT	NT	NT	NT	NT	NT	NT	3.4	225	NT	NT	<0.05	<0.01	4	NT	NT	NT	NT	NT	NT										
2/7/2006	26	6	1	10	100	130	<10	3	4.7	237	8.0	190	0.06	0.02	2	NT	<0.1	9	4.8	NT	NT										
3/1/2006	32	11	1	10	100	120	<10	3	4.6	240	7.7	190	1.1	0.02	3	NT	<0.1	10	5.3	NT	NT										
8/1/2007	29	6	1	10	100	120	<10	3	4.7	230	7.6	180	<0.05	0.01	4	NT	<0.1	10	5.1	NT	NT										
5/21/2008	29	6	1	9	110	130	<10	4	3.9	235	7.7	193	0.2	0.03	3	NT	<0.1	10	4.5	NT	NT										
7/30/2008	28	6	1	10	100	120	<10	4	5.4	237	7.2	186	<0.05	0.01	4	NT	<0.1	11	4.8	NT	NT										
6/11/2009	30	6	1	9	100	120	<10	4	3.2	237	8.0	182	<0.05	0.02	3	NT	<0.1	9	4.5	NT	NT										

Well ID: Recovery Well #2

Sample Date	Constituent																			Gross Alpha (pCi/L)
	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Conductivity (umhos/cm) at 25°C	pH	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Arsenic (ug/l)	Barium (mg/l)	Boron (mg/L)	Sulfate (mg/L)		
3/18/2004	18	4	1	17	80	100	<10	6	6.4	202	7.9	120	<0.05	<0.01	5	0.0133	ND	5	NT	
2/6/2006	21	5	1	7	80	100	<10	4	1.5	182	8.1	150	<0.05	<0.01	5	NT	<0.1	7	1.5	
3/1/2006	18	4	1	10	80	90	<10	5	3.6	186	7.8	140	<0.05	<0.01	5	NT	<0.1	5	1.5	
8/1/2007	20	5	2	14	80	90	<10	6	4.9	194	7.7	150	<0.05	<0.01	6	NT	<0.1	7	0.6	
5/21/2008	21	5	1	6	80	90	<10	5	1.7	182	7.8	139	0.07	<0.01	5	NT	<0.1	9	1.5	
7/30/2008	19	4	1	13	80	90	<10	6	5.3	195	7.3	147	<0.05	<0.01	5	NT	<0.1	8	1.3	
6/11/2009	21	5	1	7	70	90	<10	5	1.8	181	8.3	140	<0.05	<0.01	5	NT	<0.1	9	0.5	
8/26/2009	19	5	2	12	70	90	ND	7	4.8	194	8.4	148	ND	ND	6	NT	ND	8	1.2	

Well ID: Recovery Well #3

Sample Date	Constituent																			Gross Alpha (pCi/L)
	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Conductivity (umhos/cm) at 25°C	pH	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Arsenic (ug/l)	Barium (mg/l)	Boron (mg/L)	Sulfate (mg/L)		
2/6/2006	14	3	1	6	60	70	<10	2	0.5	124	8.3	99	<0.05	<0.01	8	NT	<0.01	2	0.4	
3/1/2006	13	3	<1	6	60	70	<10	2	0.9	130	7.9	97	<0.05	<0.01	6	NT	<0.1	2	0.6	
8/1/2007	14	3	1	12	60	80	<10	4	2.9	147	7.7	120	<0.05	<0.01	8	NT	<0.1	3	0.3	
5/21/2008	14	3	1	5	60	70	<10	3	1.7	130	7.8	103	<0.05	<0.01	8	NT	<0.1	5	1.8	
7/30/2008	13	3	1	11	60	70	<10	4	4.0	151	7.4	111	<0.05	<0.01	8	NT	<0.1	5	1.3	
6/11/2009	15	3	1	6	50	70	<10	3	0.9	129	8.4	102	<0.05	<0.01	8	NT	<0.1	3	1.2	
8/26/2009	13	3	1	11	60	70	ND	5	3.3	150	8.4	110	ND	ND	8	NT	ND	3	0.1	

Well ID: Recovery Well #4

Sample Date	Constituent																			Gross Alpha (pCi/L)
	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Conductivity (umhos/cm) at 25°C	pH	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Arsenic (ug/l)	Barium (mg/l)	Boron (mg/L)	Sulfate (mg/L)		
5/21&22/2008	21	4	<1	5	70	80	<10	3	2.2	162	7.7	126	0.07	<0.01	10	NT	<0.1	10	0.6	
7/30/2008	17	4	1	7	70	80	<10	3	2.7	161	6.7	125	<0.05	<0.01	9	NT	<0.1	10	2.2	
6/11/2009	23	5	<1	6	70	80	<10	3	1.9	183	8.2	135	<0.05	<0.01	9	NT	<0.1	16	3.4	
8/26/2009	19	4	1	8	70	80	ND	3	1.9	171	8.4	129	ND	ND	10	NT	ND	12	2.2	

Well ID: Recovery Well #5

Sample Date	Constituent																			Gross Alpha (pCi/L)
	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Alkalinity (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Conductivity (umhos/cm) at 25°C	pH	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Arsenic (ug/l)	Barium (mg/l)	Boron (mg/L)	Sulfate (mg/L)		
6/11/2009	18	3	1	5	60	70	<10	2	0.5	142	8.3	106	<0.05	<0.01	4	NT	<0.1	6	2.1	
8/5/2009	20	4	1	6	60	80	ND	4	0.9	156	8.0	124	60	ND	4	NT	ND	8	1.6	

Well ID: Apex Ranch Irrigation and Domestic Wells on 6/14/01

Constituent																			
Ranch Well ID	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Conductivity (umhos/cm) at 25°C	pH	TDS (mg/L)	Iron (mg/L)	Manganese (mg/L)	Arsenic (ug/l)				Sulfate (mg/L)	Gross Alpha (pCi/L)
1	36	10	2	9	149	<1.5	2.7	1.4	275	8.0	193	<0.05	0.10	2				15	10.6
2	37	8	2	12	138	<1.5	2.8	3.1	292	8.0	204	<0.05	<0.01	<2				25	5.3
4	19	5	1	7	91	<1.5	2.2	<0.4	163	8.0	107	<0.05	0.03	<2				4	2.2
5	14	4	1	5	67.2	<1.5	1.7	<0.4	126	7.7	91	<0.05	0.09	<2				4	1.5
18	52	11	2	13	184	<1.5	4.9	7.9	390	8.0	278	<0.05	<0.01	<2				35	10.5
Domestic Well 3	37	8	2	8	128	11	2.5	<0.4	269	8.2	188	<0.05	0.04	<2				13	10.6

NT: Not Tested, ND: None Detected
Laboratory: Fruit Growers Laboratory, Santa Paula, CA

APPENDIX E

Memorandum Regarding Recommendations for Monitoring Apex Ranch Conjunctive Use Project Michael Maley, Kennedy/Jenks Consultants

8 July 2011

Memorandum

To: Art Baggett
From: Michael Maley, Kennedy/Jenks Consultants
Subject: Recommendations for Monitoring
Apex Ranch Conjunctive Use Project
K/J 1164007

1. Introduction

At your request, Kennedy/Jenks Consultants (Kennedy/Jenks) has provided this technical memorandum to provide recommendations for developing a monitoring plan for the Apex Ranch Conjunctive Use Project (Apex Ranch Project).

1.1. Purpose

Kennedy/Jenks has developed these recommendations to supplement the existing monitoring plan for the Apex Ranch Conjunctive Use Project by the District. For the scope of work, existing data and reports of the project were reviewed including reports by Provost & Pritchard Consulting Group (Provost & Pritchard), Kenneth D. Schmidt and Associates (Kenneth Schmidt Associates), and Luhdorff & Scalmanini Consulting Engineers (LSCE) as well as additional information available from the Kings County Water District (KCWD), California Department of Water Resources (DWR), and the United States Geological Survey (USGS).

The objective of this task is to provide third-party outside review of the existing monitoring plan and provide recommendations to further evaluate the horizontal and vertical effects of groundwater pumping at the Apex Ranch Recovery Wells. The monitoring plan will address issues related to both groundwater levels, lateral movement of groundwater, hydrologic factors that influence groundwater levels, and changes in groundwater quality. The results of this review are documented in this technical memorandum that provides a concise summary of the comments and recommendations of the existing Apex Ranch monitoring plan. These recommendations are based on existing hydrogeologic data, reports and interpretations provided by the various consultants involved with the project, and does not provide new hydrogeological interpretations.

1.2. Previous Investigations

There have been a large number of documents that have been prepared regarding the Apex Ranch Project. For this project, Kennedy/Jenks has reviewed many of these. A list of the key documents reviewed for the preparation of this technical memorandum includes the following:

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- Provost & Pritchard and Kenneth Schmidt Associates, 2001, Hydrogeologic and Water Supply Investigation, report prepared for Kings County Water District.
- Provost & Pritchard, March 2004, Apex Ranch Conjunctive Use Project Groundwater Monitoring Program, report prepared for Kings County Water District.
- LSCE, November 7, 2008, Impacts of Apex Ranch Water Bank Extraction on Private Off-Site Wells, report prepared for Kings River Area Property Owners
- Provost & Pritchard, January 23, 2009, October 2008 through September 2009 Review and Comments on "Impacts of Apex Ranch Water Bank Extraction on Private Off-Site Wells" by LSCE, report prepared for Kings County Water District.
- LSCE, January 26, 2009, Summary Review and Comments on Apex Ranch Groundwater Bank Project, PowerPoint presentation
- Provost & Pritchard, March 19, 2009, Apex Ranch Pump Test, report prepared for Kings County Water District.
- Provost & Pritchard and Kenneth Schmidt Associates, May 2009, Apex Ranch Monitoring & Mitigation Plan for 2009 Summer Recovery Operations, report prepared for Kings County Water District.
- Kenneth Schmidt Associates, July 10, 2009, Projected Drawdowns due to Pumping of the Apex Ranch Recovery Wells, report prepared for Kings County Water District.
- Kenneth Schmidt Associates, October 8, 2009, Drawdowns due to 2009 Pumping of the Apex Ranch Recovery Wells, report prepared for Kings County Water District.
- Provost & Pritchard, October 2009, October 2008 through September 2009 Groundwater Monitoring Program for Apex Ranch Project, report prepared for Kings County Water District.
- LSCE, February 2010, Impacts of Apex Ranch Water Bank Extraction on Private Off-Site Wells, report prepared for Kings River Area Property Owners
- Provost & Pritchard, March 2011, October 2009 through September 2010 Groundwater Monitoring Program for Apex Ranch Project, report prepared for Kings County Water District.

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2. Background

Development of recommendations for the groundwater monitoring program Apex Ranch Project requires an understanding of the background and issues that need to be addressed by the monitoring program. Below is a brief overview of this understanding.

2.1. Apex Ranch Project

The Apex Ranch Project is located along an abandoned stretch of the Kings River (old channel) in northern Kings County (Figure 1). The District initiated evaluation of the Apex Ranch Project in 2001. In 2002, the District purchased the Ranch with the purpose of developing a conjunction use project. Apex Ranch Project operations began in 2002.

The purpose of the Apex Ranch Project is to divert Kings River water during the fall and winter months when water is available into the old channel where a series of small dams impounds that water so that it is allowed to infiltrate to the groundwater. The intent was to recharge groundwater in a manner that would resemble historical recharge patterns when the river flowed through the old channel. Groundwater recharge would be from the surface so that recharge would be to the shallow groundwater.

Groundwater recovery is performed in the summer and fall months. Groundwater is pumped from five (5) recovery wells located on the Apex Ranch Project and put into the People's Ditch located on the east side of the Project. The water from the Apex Ranch is delivered for use in other parts of the District. These recovery wells have different screened intervals ranging from about 70 to 800 feet below ground surface.

The KCWD has implemented a groundwater monitoring plan for the Apex Ranch to monitor changes in groundwater levels in a number of wells in the vicinity of the Apex Ranch Project (Figure 2). The monitoring network has grown from an initial set of 14 wells in 2002 and 2003 to 80 wells in 2009. In 2010, 48 wells were monitored. In 2010, these consist of 25 wells located on the Apex Ranch property and 23 wells offsite wells that include 14 agricultural wells, 3 unused agricultural wells, 4 domestic wells and 2 unused domestic wells.

2.2. Overview of Hydrogeology

A summary of the geology under the Apex Ranch site is summarized from the July 10, 2009 report by Kenneth Schmidt Associates. Figure 3 shows a north-south geologic cross section across the Apex Ranch Site. The section primarily of coarse grained sands and gravels with interbedded fine-grained layers of silt and clay.

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There are two fine-grained silt and clay layers that are interpreted as being relatively continuous across the site. The first fine-grained layer is about 120 to 130 feet in depth and is a 10 to 15 foot interval of mostly clay. The second fine-grained layer is between 200 and 250 feet in depth and is about 10 to 30 feet thick.

These two layers are interpreted as acting as confining layers for the deeper groundwater. The implication of this interpretation is that the groundwater is subdivided into zones with each having its own groundwater characteristics. These zones are defined as follows:

- The shallow zone is the interval above the first fine-grained layer.
- The intermediate zone is the interval between the first and second fine-grained layers.
- The deep zone is below the second fine-grained layer.

The Apex Ranch Recovery Wells are completed across the shallow, intermediate and deep Zones. Based on the estimates by Kenneth Schmidt Associates, this is apportioned as 12 percent from the shallow zone, 14 percent from the intermediate Zone, and 74 percent from the deep zone. Moving the pumping to the deep zone is discussed as part of the objective to shift pumping for the Apex Ranch Project to the deeper intervals to help minimize impacts on agricultural and domestic wells in the area which are predominantly completed in the shallow and intermediate zones.

The differences in groundwater conditions are interpreted to include a response to groundwater pumping that varies with depth and is related to the groundwater zone. Figure 4 shows the response to pumping for two monitor wells located on Apex Ranch. MW-1 is a shallow zone well whereas MW-3 is a deep zone well. These wells are located in close proximity to the Apex Ranch Recovery Wells. MW-1 shows a drawdown of 10 to 15 feet whereas MW-3 shows a drawdown of over 70 feet. This has been interpreted as demonstrating that drawdowns from Apex Ranch pumping is primarily in the deep zone with significantly less impacts in the shallow and intermediate zones.

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3. Understanding of the Issues

Several issues have been discussed with respect to the operation of the Apex Ranch Project. Understanding of these issues is important for developing recommendations for additional groundwater monitoring. A brief overview of these issues is provided below.

3.1. Interference with Nearby Agricultural and Domestic Wells

In 2009, KCWD received six complaints from neighboring landowners about wells with low groundwater levels that reduced or eliminated their ability to produce water from these wells. Figure 5 shows the locations of these wells. The issue is whether groundwater levels in off-site agricultural and domestic supply wells decline excessively due to Apex Ranch Project pumping operations resulting in increased pumping costs or forcing wells out of production.

The potential causes could be a result of either Apex Ranch Project operations or from other causes. A summary of the potential causes for groundwater level declines in the impacted wells can be summarized as follows:

- Overview of Possible Causes due to Apex Ranch Project Operations
 - Regional
 - Confining layer is missing or leaky over a large area causing the aquifer to act more as a single unit rather than an shallow, intermediate and deep zones
 - Local
 - Confining layer has holes that allow local leakage between shallow and deep zones
 - Impacted well within zone of influence of shallow zone pumping at Apex Ranch
 - Well Specific
 - Well is completed in shallow and deep zones providing vertical conduit so that the well is influenced by Apex Ranch pumping from the deep zone.
- Overview of Possible Non-Apex Ranch Causes
 - Regional
 - Regional changes can be the result of changes in groundwater pumping over time and from variation in climatic conditions such as droughts
 - Local
 - Other nearby wells increased pumping that caused observed effects

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- Well Specific
 - Well was not able to sustain typical variations in groundwater levels due to well construction, clogging, or pump placement

Monitoring for this issue would focus on developing a database of groundwater levels that can characterize the vertical differences in groundwater levels of the shallow, intermediate and deep zones. This would include regular monitoring throughout the year with focused monitoring during operations of the Apex Ranch Project. Pumping tests using the Apex Ranch Project pumping wells should be run periodically during different hydrologic conditions to build up a sufficient understanding of how the aquifer responds to pumping. These data would be to support further groundwater analysis regarding this issue.

3.2. Influence of Regional Groundwater Levels

Regional groundwater conditions also have an effect on groundwater conditions in the Apex Ranch Project area. The question would be whether these regional fluctuations are primarily responsible for the observed conditions in the off-site wells where the complaints were filed. Regional trends in much of the San Joaquin valley have been for groundwater levels to have generally declined over the past 30 years in response to increased pumping. The impacts of these regional trends can have far reaching affects.

Monitoring for this issue would be collection and evaluation of regional groundwater levels. The Kings River Conservation District collects regional groundwater data that is submitted to the California Department of Water Resources. There seems to be sufficient data collected to define the regional trends and no additional monitoring is recommended.

3.3. Dissipation of the Groundwater Mound

Another issue is what happens to the water recharge by the Apex Ranch Project. The operations of the Apex Ranch Project are that water is recharged at the surface into the shallow zone; however, pumping for the Apex Ranch Project is from the deep zone. Also, recharge and pumping operations have not necessarily balanced on an annual basis. There is a question as to whether the recharge water is available during the pumping operations or not.

A second point of view is that the recharge operations from the Apex Ranch Project provide a net benefit to the groundwater conditions in the shallow zone in the vicinity of Apex Ranch. The pumping operations from the deep zone are not intended to capture the recharge operations.

Monitoring for this issue would focus of having sufficient density of monitoring locations both horizontally and vertically in the vicinity of the Apex Ranch Operations. Regular monitoring

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would continue throughout the year with focused monitoring during recharge operations of the Apex Ranch Project. These data would be to support further groundwater analysis regarding this issue.

3.4. Interference with King's River Recharge

It has been suggested that recharge operations at Apex Ranch interfere with the natural recharge along the Cole Slough Reach of the King's River. The concern is that the groundwater mound that develops as a result of recharge operations at the Apex Ranch may raise groundwater levels near Cole Slough such that it would limit the natural recharge that occurs along the Kings River. If this is occurring, it has been suggested that the amount of reduced recharge from Cole Slough should be deducted from the amount of storage calculated for the Apex Ranch Project.

The observation is that a groundwater recharge project should be more perpendicular rather than parallel to the existing river channel. The Old River channel is essentially parallel to Cole Slough; however, it should be noted that the primary recharge locations for the Apex Ranch Project are in the upper reaches of the Old Channel which is more perpendicular to Cole Slough.

Monitoring for this issue would focus of having sufficient monitoring locations along Cole Slough to collect data during Apex Ranch Project recharge operations to determine if groundwater levels increase to a level that would interfere with recharge along Cole Slough. These data would be to support further groundwater analysis regarding the evaluation of whether this issue occurs or not.

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4. Monitoring Plan Recommendations

The recommendations for the Apex Ranch Monitoring Plan were developed with the idea of developing a clear link of understanding the potential causes of the observed water level issues in the offsite wells where complaints have been filed and developing a monitoring program that provides as direct a test as possible based on the understanding of the hydrogeology of the area.

4.1. Increase Monitoring Well Network

The recommendation is to add the following wells to the network of 48 wells used for the groundwater monitoring well network in 2010.

4.1.1. Define a Network of Deep Zone Monitoring Wells

The conceptualization of the groundwater of consisting of a shallow, intermediate and deep zone will require additional monitor wells to help distinguish the differences in the impacts for each of the zones. The well logs in the area should be reviewed to classify existing wells into their proper zone designation and identify new wells to supplement the monitoring network that define groundwater conditions in the deep zone. Locating and gaining access to these deep zone wells

- Specifications
 - Wells should have the entire screened interval below a depth of 250 feet
 - Where possible, preference should be given to selecting wells that have an annular seal that limits the potential for groundwater flow along the gravel pack from above 250 feet.
- Location and Distribution of deep zone Wells
 - Evaluate potential wells up to 3 miles for deep wells to define extent of Apex effects
 - Review well logs or other sources of information to identify wells that have screened intervals that do not extend above a depth of 250 feet.
 - Figure 6 shows a grid over the project area. The goal is to include at least one deep zone well in each grid block that can be used for future contouring of groundwater levels in the deep zone.
 - Additional deep zone wells can be added as available. These can be either multiple wells within a grid block or wells outside of the grid block area.

It is understood that most agricultural and domestic wells in the area are typically completed as shallow zone wells. Wells with screened intervals that extend into the deep zone are often also open to the shallow zone. Because of these logistical difficulties, it is considered

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preferable to have a less than optimal well rather than no well. Therefore, the deep zone well network may include wells that have gravel packs that extend above 250 feet, but should not include wells with screened intervals that extend above 250 feet. The annual space of the gravel pack provides some limitation to groundwater flow,

4.1.2. Add Shallow Zone Wells near Cole Slough

To help understand the groundwater-surface water interactions of the shallow zone with Cole Slough, additional shallow zone wells should be added to the monitoring network that are located near Cole Slough. It is anticipated that existing wells can be used. The well logs in the area should be reviewed identify new wells to supplement the monitoring network that define groundwater conditions in the shallow zone along Cole Slough, as follows:

- Specifications
 - Wells should screened intervals that do not extend below 125 feet.
 - Preference should be given to wells that are no longer used for pumping or are rarely used for pumping.
- Location and Distribution of deep zone Wells
 - Review well logs or other sources of information to identify wells that have screened intervals that do not extend below a depth of 125 feet.
 - Shallow zone wells should be located within ½ mile either side of Cole Slough and within 4 miles downstream of People's Weir.
 - Four of the 2010 monitoring well network wells appear located within this range.
 - A minimum of 4 additional wells should be located and added to the monitoring well network. At least two of these wells should be located north of Cole Slough.
 - The selected wells should not be located with ¼ mile of each other.

4.1.3. Nested Well Clusters to Differentiate Vertical Aquifer Characteristics

To further supplement the ability to define the vertical differences in groundwater responses to pumping, it is recommended that dedicated monitoring wells clusters be installed in the shallow, intermediate and deep zone to further help distinguish the differences in the impacts for each of the zones. The locations of these well clusters will require logistical support to be finalized based on site access and land use constraints. A summary of the recommendations for the well clusters includes the following:

- Nested well clusters
 - Dedicated monitoring wells, not pumping wells
 - The cluster of wells should include wells completed in shallow, intermediate and two deep zones
 - Make use of existing wells where possible

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- Wells need to be located within close proximity of one another with wells no more than 100 feet apart.
- Locations of Well Clusters
 - Two well clusters should be located on the Apex Ranch property.
 - One location to the north near Ranch Well #4 (See Figure 7)
 - One location along the western property boundary west of Ranch Well 19 (See Figure 7).
 - Two off-site well clusters should be located west of the Apex Ranch property.
 - One location should be located about ½ mile west of the Apex Ranch property boundary in the vicinity of Well 23D0x1 (See Figure 7).
 - One location should be located about 1.5 miles west of the Apex Ranch property boundary in the vicinity between Burris Park and Well 16J01 (See Figure 7)
 - The guidelines for locating the offsite well clusters can be varied to accommodate logistical and site access issues. The offsite wells should be located along a roughly east-west line extending east from the southern on-site well cluster location with wells spacings that approximate as closely as possible the spacings of ½ and 1.5 miles.
- Specifications of Well Clusters
 - Well screens should be no more than 20 feet in length and must be completed within a particular aquifer zone
 - The annular space must be sealed to prevent hydraulic communication within the gravel pack.
 - The on-site well clusters should consist of four wells
 - The shallow zone wells should be completed below 125 feet.
 - The intermediate well should be completed between 125 feet and 250 feet.
 - One deep zone wells should be completed between 300 and 400 feet.
 - One deep zone well should be completed below 450 feet.
 - The off-site well clusters should consist of at least two wells, but four would be preferable if costs allow.
 - The shallow zone wells should be completed below 125 feet.
 - One deep zone wells should be completed between 300 and 400 feet.

4.2. Groundwater Level Measurements

Groundwater level measurements are the primary data set necessary for evaluating groundwater conditions related to the operations of the Apex Ranch Project and other local and regional influences. A period of more detailed groundwater level measurements is recommended to build a data set to help resolve the issues being discussed. This monitoring program is anticipated to be temporary until an operating agreement is reached that will include

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and updated monitoring program. The elements of this detailed monitoring program include the following:

- Location and methods of monitoring well network
 - The monitoring network should include the 48 wells included in the 2010 monitoring schedule.
 - New monitoring wells added the monitoring network from the above recommendations should added to this monitoring schedule as they become available.
 - Groundwater levels should be collected using an industry standard electronic water level monitoring probe or other similar measuring device
 - Groundwater levels should be collected by an experienced technician from either KCWD staff and/or consultants, or Kings River Conservation District staff.
- Basic groundwater level measurement frequency
 - Monthly groundwater levels should be collected from wells located on the Apex Ranch property.
 - Groundwater levels from off-site wells should be collected at least every two months with recommended months being February, April, June, August, October, and December.
 - The purpose of the basic measurement frequency is to build up a more detailed database of groundwater levels when the Apex Ranch Project is not pumping. This is to help understand conditions during recharge and non-operating periods. This will also provide more detailed information on regional issues not related to the Apex Ranch Project.
- Frequency of monitoring during Apex Ranch Project pumping operations
 - Measurements taken one and two weeks prior to the planned initiation of pumping operations.
 - Measurements taken within one, two and four weeks after the start of pumping operations.
 - After 4 weeks, measurements taken every four weeks until planned end of pumping period.
 - Measurements collected within one week before end of pumping.
 - Measurements collected within one week after end of pumping.
 - Measurements taken within one, two and four weeks after the end of pumping

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- Frequency of monitoring during upon commencement of flow into or termination of flows from the Consolidated Irrigation Districts' canal, commencement of recharge operation by Kings County Water District, or other diversions into the Old River.
 - Measurements taken one and two weeks prior to the planned initiation of recharge.
 - Measurements taken within one, two and four weeks after the start of recharge operations.
 - After 4 weeks, measurements taken every four weeks until planned end of recharge period.
 - Measurements collected within one week before end of recharge.
 - Measurements collected within one week after end of recharge.
 - Measurements taken within one, two and four weeks after the end of recharge operations.
- Analysis of data
 - Plot and contour groundwater elevations for each groundwater level measurement data set for the shallow and deep zones.
 - Plot and contour change in groundwater levels before pumping to each interval after pumping
 - Plot hydrographs for each well where data is collected

4.3. Apex Ranch Pumping Test

The potential causes for impacts to the offsite wells include local and well specific causes. A pumping test provides a mechanism to evaluate these smaller scale issues by stressing the aquifer.

It is understood that high water conditions will influence groundwater conditions especially in the shallow zone. This test may not provide a direct comparison to the well interference conditions experienced in 2008. Drawdowns observed in wells under high water conditions will provide a direct confirmation of well interference; however, lack of a response may be inconclusive because of the high water conditions.

The focus of the test will be to build up the data to evaluate groundwater conditions near the Apex Ranch including during high water conditions and to focus on collecting data from the deep zone especially if offsite deep zone wells are located and available. The emphasis will be to monitor onsite wells, nearby offsite wells and deep zone offsite wells (if available). The high water conditions provide an opportunity to evaluate the groundwater-surface water interactions. This will also be important in developing the hydrogeologic understanding and for eventually developing operational standards.

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A summary of the recommendations for the pumping test includes the following:

- Purpose
 - Based on our current understanding, the pumping test will be conducted in February 2012 after the installation of the nested well clusters. The start date can vary to accommodate logistical and other operational issues that may arise.
 - The test will consist of
 - At least 5 days of data collection prior to the start of pumping.
 - 20 days of groundwater pumping with two groups of pumping wells
 - At least 5 days of data collection after the end of pumping.
- Test Design
 - Pump Recovery Wells 2, 3 and 5 for 10 days. After 10 days, pump from Recovery wells 1, 2, 3, 4 and 5 for 10 additional days. Total period of pumping is 20 days.
 - Pump Recovery Wells 2, 3 and 5 at pumping rates of 3,500, 5,000 and 5,500 gallons per minute (gpm) respectively.
 - After 10 days, also pump Recovery Wells 1 and 4 at pumping rates of 2,200 and 4,600 gallons per minute (gpm) respectively.
 - Total volume of pumped groundwater for the test is estimated at about 1,500 acre-feet.
- Monitoring Network
 - Monitor groundwater levels in all on-site wells including
 - MW-1, 2 and 3;
 - Ranch Wells, 1, 3, 4, 6, 7 12, 17 and 19;
 - Domestic Wells 1, 2, 3 and 4
 - Monitor groundwater levels in offsite wells near to the Apex Ranch
 - Offsite wells are to be determined based on logistics and access. A proposed distribution of offsite monitor wells is provided.
 - 2 wells from T17S/R22E Section 11
 - 2 wells from T17S/R22E Section 12
 - 2 wells from T17S/R22E Section 13
 - 2 wells from T17S/R22E Section 14
 - 1 well from T17S/R22E Section 23
 - 1 well from NW1/4 T17S/R22E Section 24
 - Monitor groundwater levels in offsite wells completed in the deep zone within 3 miles of Apex Ranch
 - These are not currently identified. Well logs and other information should be reviewed to identify these wells.

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- **Monitoring Procedures**
 - It is recommended that electronic pressure transducers be installed in all the monitoring wells for the duration of the test.
 - Pressure transducers should be installed and collect groundwater levels for at least 5 days prior to the start of the test to establish background conditions
 - Pressure transducers should be left in the monitoring wells for at least 5 days after the end of the pumping to collect groundwater levels during the recovery phase.
 - Hand measurements should be collected to verify transducer data at least once every 3 days over the 30 days of the test including the background, pumping and recovery data collection periods.
 - It is recommended that the test be conducted by KCWD staff or consultants with oversight from the Kings River Conservation District.
- **Analysis of Results**
 - It is recommended that analysis of the aquifer test results be conducted by an independent third party with the experience and technical ability to evaluate the results.
 - Review and comments on the results of third party analysis will be provided by the staff or designated representatives of KCWD and Kings River Area Property Owners.

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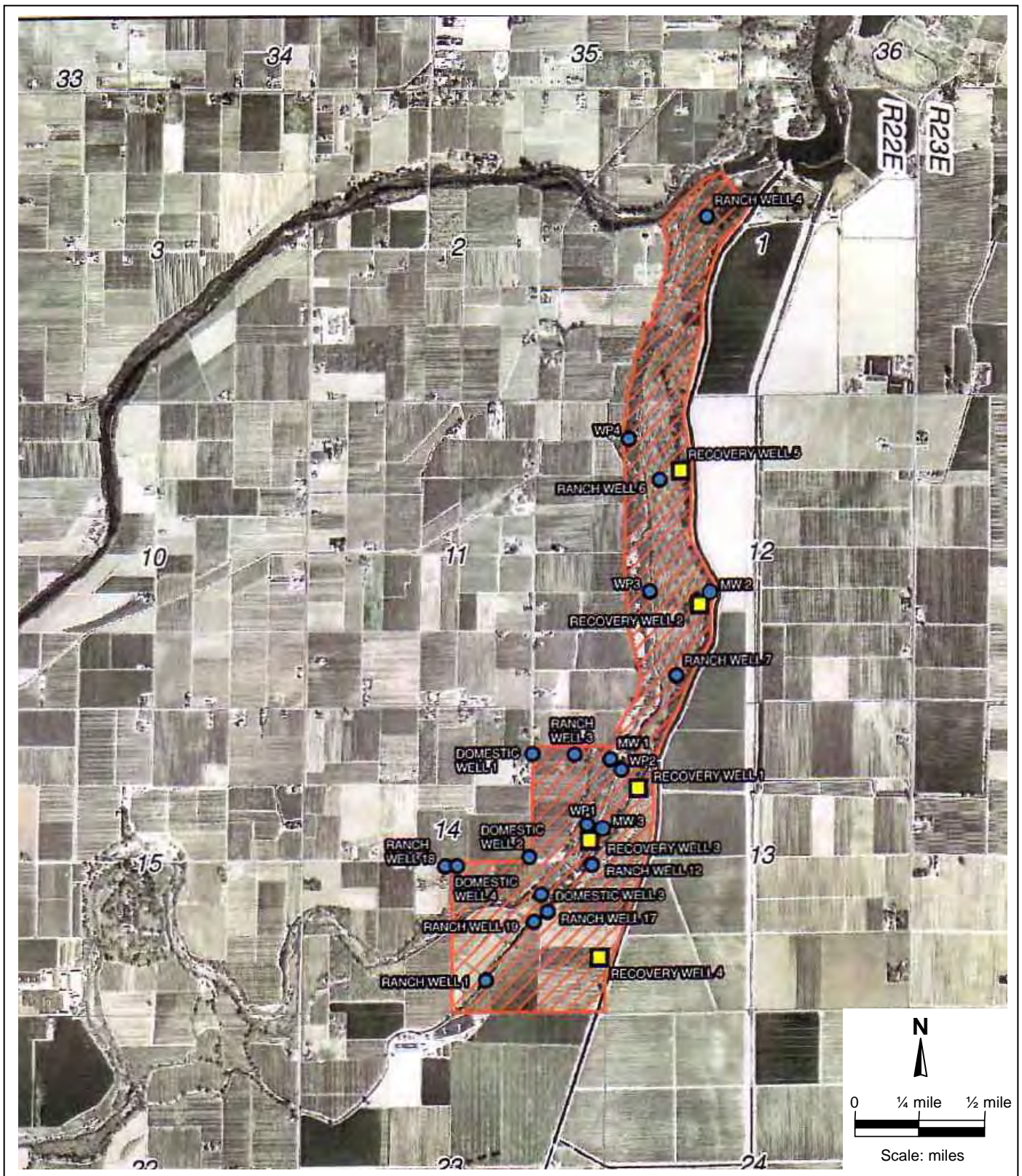
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Figure List

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| Figure 2 | Location of Apex Ranch Project 2010 Groundwater Monitoring Wells |
| Figure 3 | Cross Section showing Shallow, Intermediate and Deep Zones |
| Figure 4 | Hydrographs of Apex Ranch Project Wells MW-1 and MW-3 for 2009 |
| Figure 5 | Location of wells with complaints filed with KCWD in 2009 |
| Figure 6 | Location Grid for Deep Monitoring Wells |
| Figure 7 | Recommended locations for Apex Ranch Project Monitoring Well Clusters |



Note: Map taken from Plate 3, Provost & Pritchard,
March 2011, October 2009 through September 2010
Groundwater Monitoring Program
for Apex Ranch Project

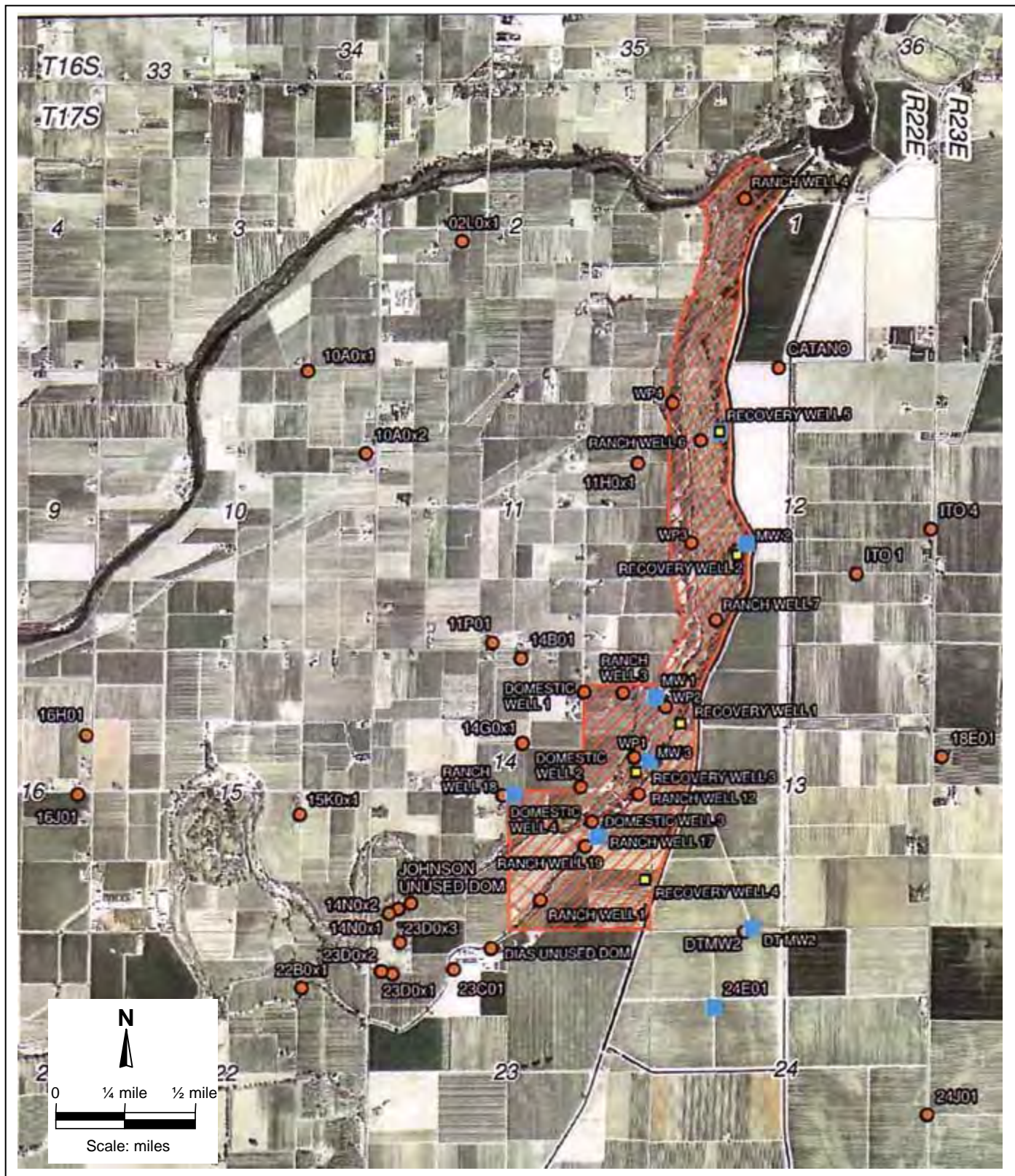
Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

Location of Apex Ranch Project and On-site Project Wells

K/J Project 1164007
June 2011

Figure 1



Note: Map taken from Plate 4, Provost & Pritchard,
March 2011, October 2009 through September 2010
Groundwater Monitoring Program
for Apex Ranch Project

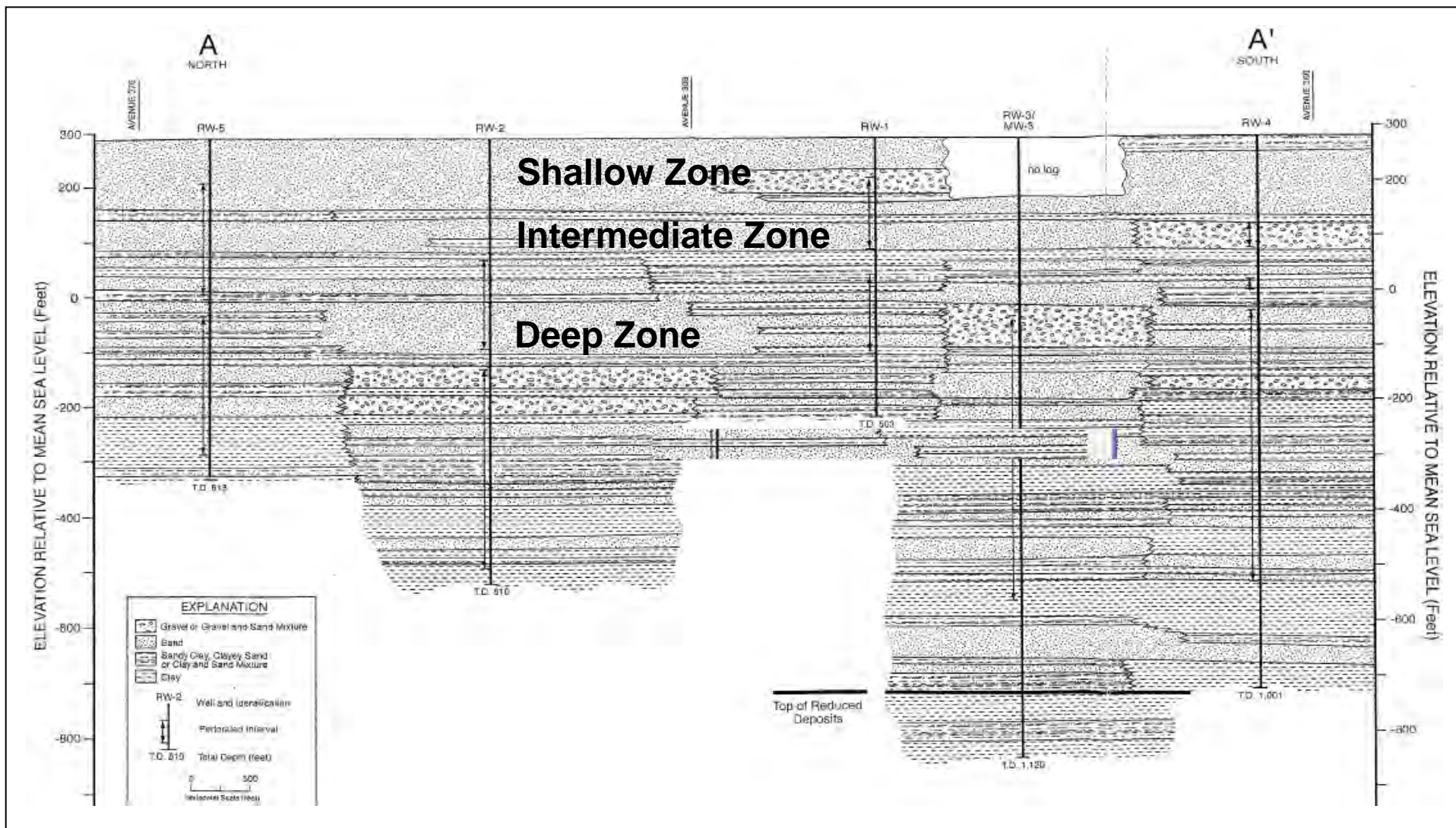
Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

**Location of Apex Ranch Project 2010
Groundwater Monitoring Wells**

K/J Project 1164007
June 2011

Figure 2



**Note: Cross Section from
Kenneth Schmidt Associates, July 10, 2009,
Projected Drawdowns due to Pumping
of the Apex Ranch Recovery Wells**

Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

**Cross Section showing Shallow,
Intermediate and Deep Zones**

K/J Project 1164007
June 2011

Figure 3

Apex Ranch Monitor Well 1 Water Level Hydrograph 2009 Water Year

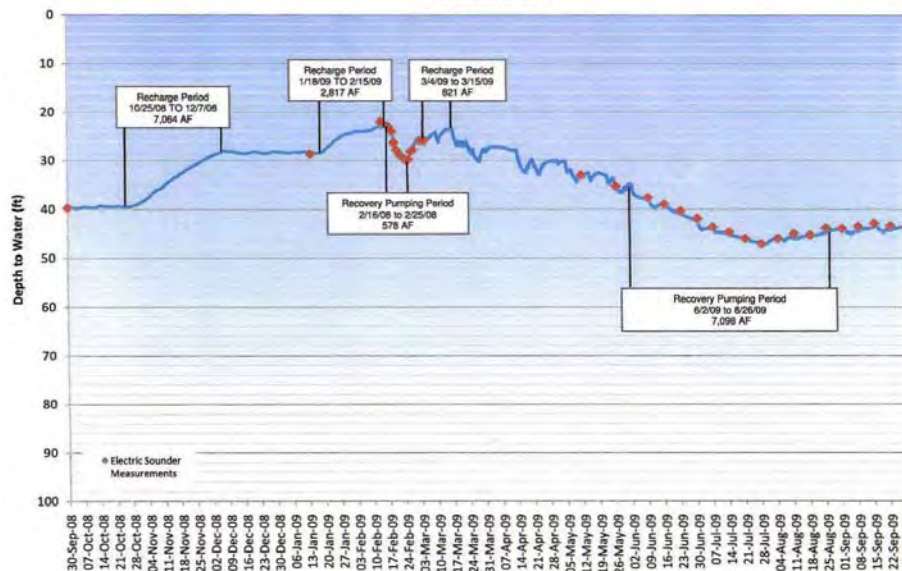
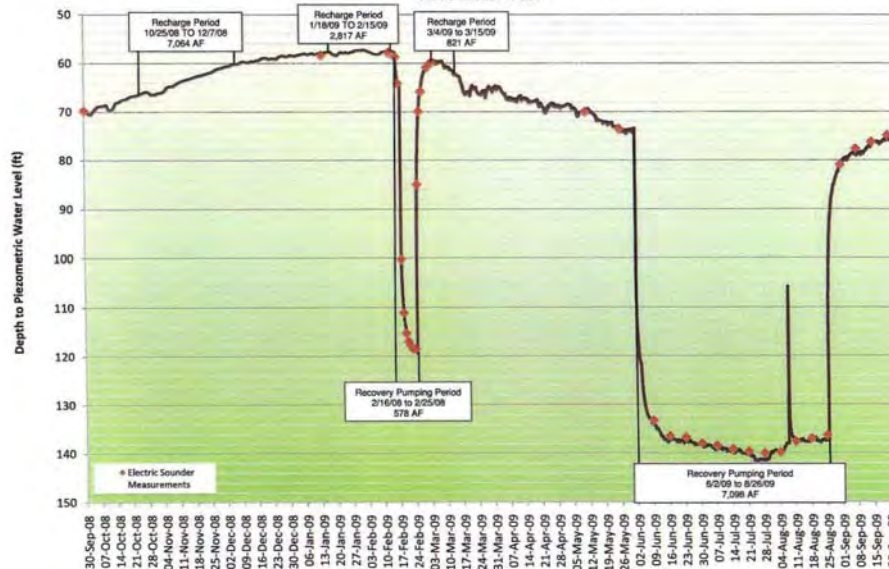


FIGURE 3-3

Apex Ranch Monitor Well 3 Water Level Hydrograph 2009 Water Year



Note: Graphs taken from Figures 3-1 and 3-3,
Provost & Pritchard, October 2009,
October 2008 through September 2009
Groundwater Monitoring Program
for Apex Ranch Project

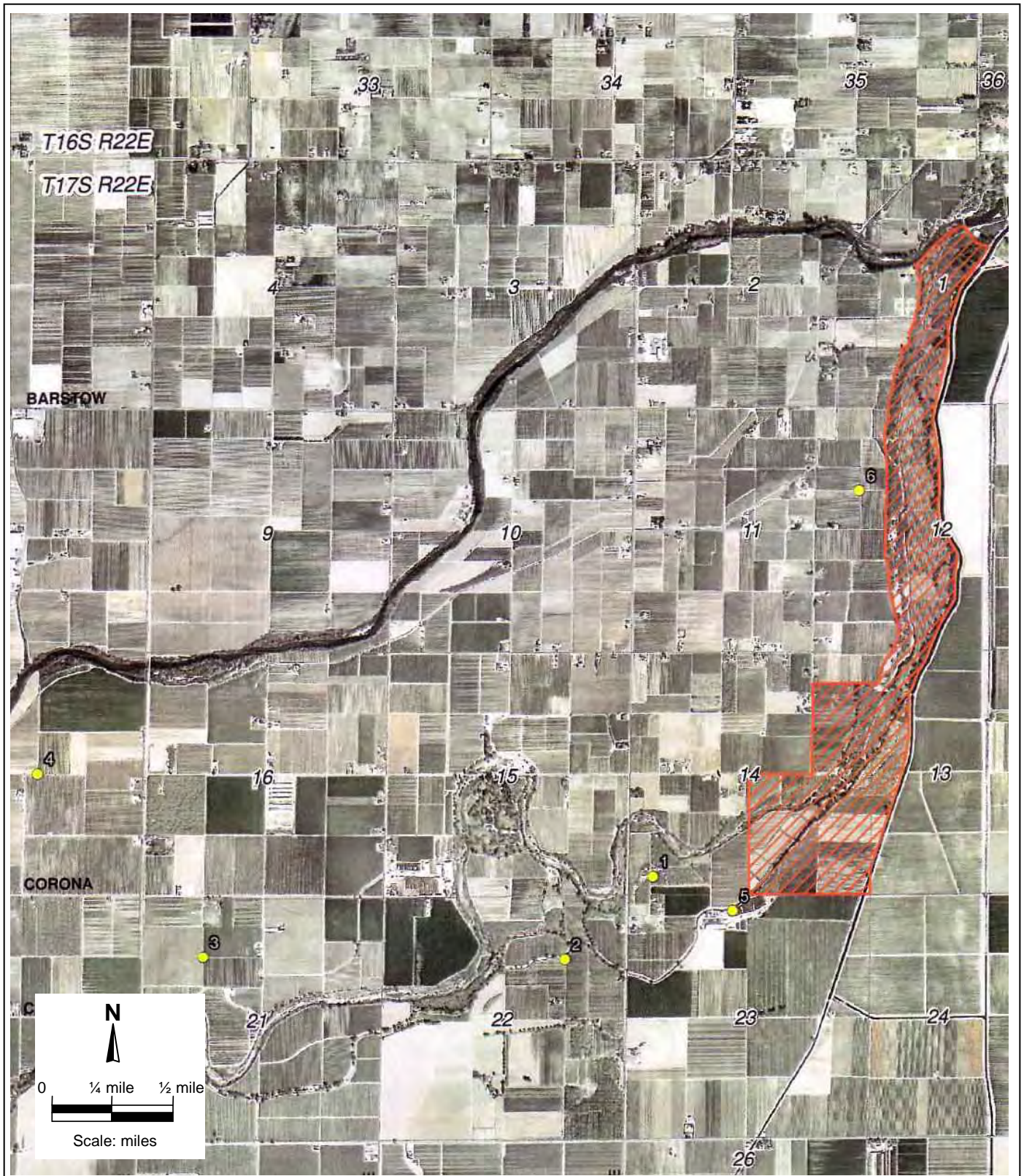
Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

**Hydrographs of Apex Ranch Project
Wells MW-1 and MW-3 for 2009**

K/J Project 1164007
June 2011

Figure 4



Note: Map from Provost & Pritchard

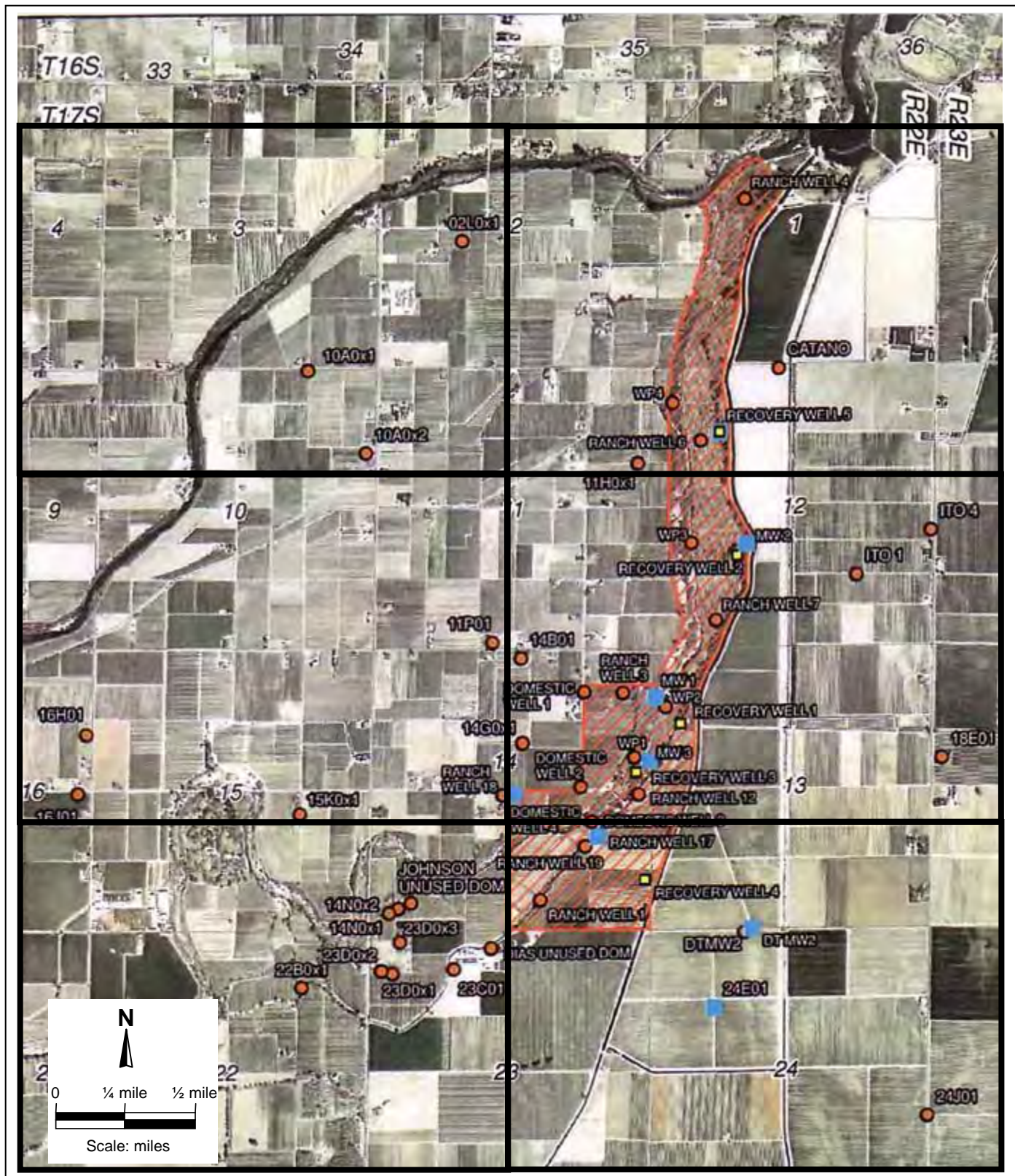
Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
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**Location of wells with complaints filed
with KCWD in 2009**

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Figure 5



Note: Map taken from Plate 4, Provost & Pritchard,
March 2011, October 2009 through September 2010
Groundwater Monitoring Program
for Apex Ranch Project

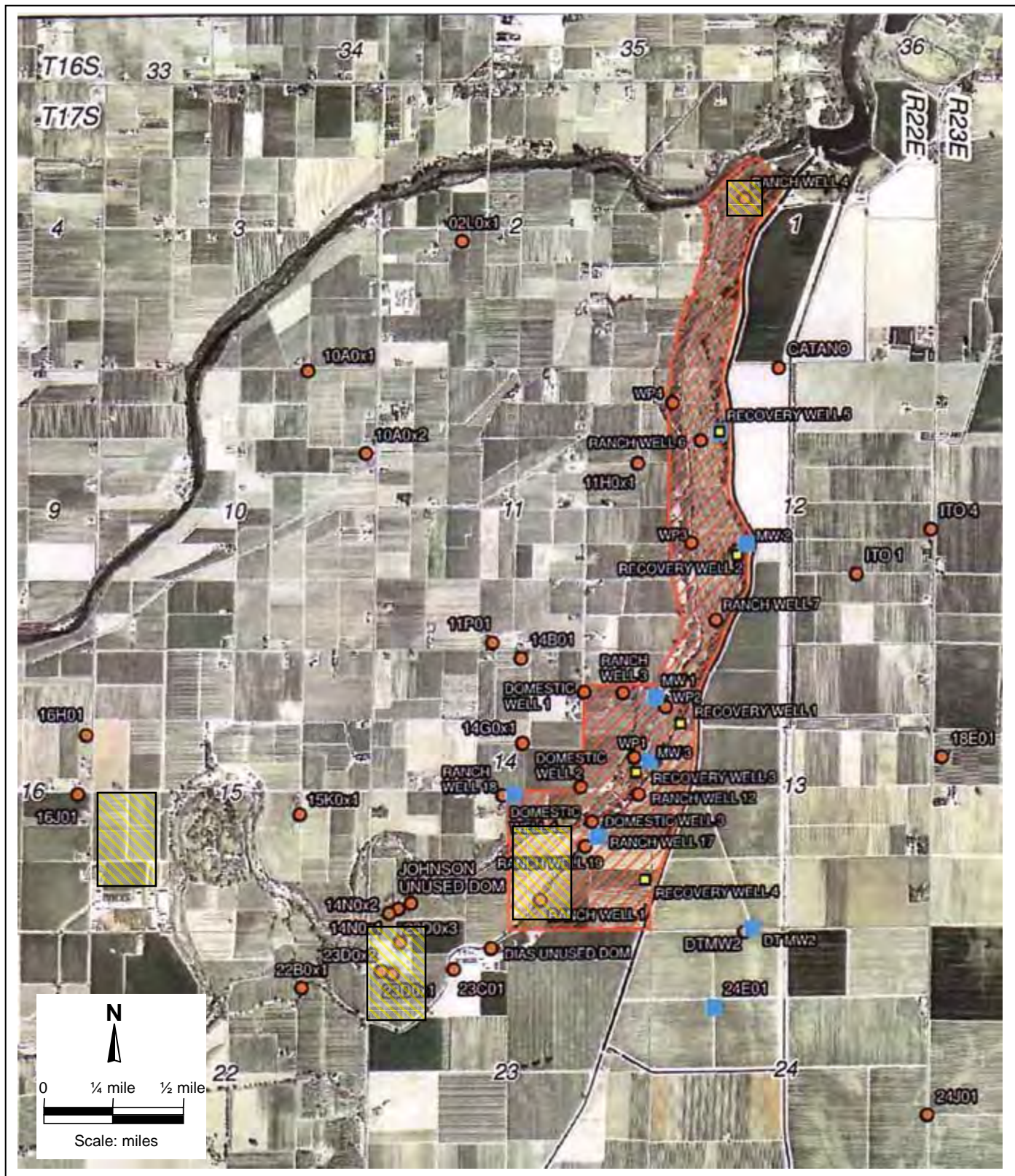
Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

Location Grid for Deep Monitoring Wells

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Figure 6



Recommended location for Monitoring Well Cluster

Note: Map taken from Plate 4, Provost & Pritchard,
March 2011, October 2009 through September 2010
Groundwater Monitoring Program
for Apex Ranch Project

Kennedy/Jenks Consultants

Recommendations for Groundwater Monitoring
Apex Ranch Conjunctive Use Project

Recommended locations for Apex Ranch Project Monitoring Well Clusters

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Figure 7

APPENDIX F
Apex Ranch Conjunctive Use Project
Groundwater Monitoring Program
2012 Update to 2004 Guidelines

SECTION 1 Description of Monitoring Program

1.1 Introduction

The purpose of the Apex Ranch Conjunctive Use Project's (Project) Groundwater Monitoring Program (Program), which was instituted as a part of the Project's 2004 Annual Report, is to gather data to utilize and analyze the effect of the Project's recharge and recovery operations on local groundwater conditions. In an effort to alleviate concerns brought forth to the Kings County Water District (District) by local landowners, the District, in conjunction with the Kings River Conservation District and members of the Kings River Area Property Owners, hired an outside firm, Kennedy/Jenks Consultants (Kennedy/Jenks) to conduct a study of the operations of the program.

1.2 Project Operations

The primary water source applied to the Project is that from the Kings River and its tributaries. Other waters that are periodically delivered to the Project are that from the San Joaquin River through the Friant Division of the Central Valley Project. These waters are conveyed to the Project site through the Peoples Ditch (Peoples), whose headgate is located near the northern boundary of the Project site. Surface water deliveries are measured using two methodologies. When deliveries are solely being conveyed to the Project site, measurements are conducted at the People's Ditch measuring flume, located directly downstream of the Peoples Headgate. During Peoples regular operational periods, water being delivered to the Project is measured at the Old River Turnout. Currently, there are two forms of measuring devices installed at the Old River Turnout, a chart recorder and an open-flow digital propeller flowmeter. The majority of the measurements are recorded using the propeller flowmeter; high flows, in excess of 120 gallons per minute, are recorded using the chart recorder.

Currently, when deliveries are being conveyed to the Project or to the Old River, downstream of the Project, recordings are made daily by Peoples staff and spot checked periodically by District staff. For 2012, District staff will record readings on a weekly basis.

1.3 Old River Operations

Since Project inception, deliveries to the Old River were measured at Dam 1. This year, the measurement point for deliveries made to the Old River is Dam A.

1.3 Description of Monitoring Network

The objective of the Project's Groundwater Monitoring Program has been to determine the effect of the Project's recharge and recovery operations on local groundwater conditions. The 2011 monitoring network consisted of the Project's five recovery wells, three monitor wells, twenty-two agricultural wells, four unused agricultural wells, eight domestic wells, two unused domestic wells, and four shallow well points. All the well locations within the network are located either on the Project

site or within two miles of the Project. In an effort to continuously monitor the groundwater trends within the area, the District has eight continuous water level recorders installed both on and off the Project site.

Proposed changes to the monitoring network include:

- Local Landowners will identify six deep zone monitoring wells to be added to the network,
- Local Landowners will identify four shallow zone monitoring wells near Cole Slough,
- District to construct four dedicated nested monitoring wells.

The addition of deep zone monitoring wells would include the addition of wells which have their entire screened interval below a depth of 250 feet, and where possible, preference should be given to selected wells that have an annular seal that limits the potential for groundwater flow along the gravel pack from above 250 feet.

The addition of shallow zone wells near Cole Slough would be accomplished to help understand the groundwater-surface water interactions of the shallow zone as it pertains to Cole Slough. Addition of these wells would be limited to the well intervals not extending below a depth of 125 feet. Preferences should be given to wells that meet that criteria, but are no longer or rarely operational.

The addition of the nested monitor wells will include two located on the Project property, one located one-half mile southwest, and one located a little less than two miles west of the Project. Each location will consist of three separate wells, shallow, intermediate and deep. The shallow zoned well will be planned to be completed to a total depth of 120 feet, with perforated casing between 100 feet and 120 feet. The intermediate well will be completed to a depth of 245 feet, with perforated casing between 225 feet and 245 feet. The deep well will be completed to a depth of 550 feet, with perforated casing between 500 feet and 550 feet. Each well, at each location, will have continuous water level recorders installed to allow the District to continually monitor the groundwater movement in each zone. These cluster monitor wells will be added to the network.

1.5 Water Level Monitoring

The objective of the water level monitoring portion of the 2004 Program was to install continuous water level recorders in two of the shallow monitor wells and two of the deep monitor wells.

The following lists the frequency of water level measurements:

- Semi-annual measurements will be conducted in the spring (April) and fall (September).

- During Project recharge operations, two weeks prior to and one week before the commencement of the operation period with all locations within the network to be monitored during the first, second and fourth weeks following the startup of the recharge operations, and monthly thereafter. Further, one week prior to, and the first second and fourth week following the cessation of recharge operations water levels will be measured.
- During Project recovery operations, two weeks prior to and one week before the commencement of the operation period with all locations within the network to be monitored during the first, second and fourth weeks following the startup of the recovery operations, and monthly thereafter. Further, one week prior to, and the first second and fourth week following the cessation of recovery operations water levels will be measured.

The Table lists the actions in a tabular form:

Revised Kings County Water District Water Level Monitoring Schedule

Event	2 Weeks Prior	1 Week Prior	1 Week After	2 Weeks After	4 Weeks After	Every 4 Weeks	Every Other Month	April	September
Start of Recovery	x	x	x	x	x	x			
End of Recovery		x	x	x	x				
Start of Recharge	x	x	x	x	x	x			
End of Recharge		x	x	x	x				
Fall								x	
Spring									x ²
Annually							x ¹		

Note 1. Measurements will be conducted at the beginning of every October, December, February, April, June, and August
 2. September water level readings can coincide with the October bi-monthly readings

1.6 Water Quality Monitoring

Included in the Project's 2004 monitoring network guidelines, instructions were placed to conduct water quality testing on all recovery wells; and monitor well 1 (Electrical Conductivity and Total Dissolved Solids only). The 2004 guidelines indicated that samples will be conducted and analyzed twice a year, with one set scheduled following two weeks of pumping operations and the other approximately one week prior to the completion of the pumping operations. If there is no apparent change after five years of operation, then sampling can be performed less frequently.

There are no proposed changes to the current water quality plan, with the exception that the District will continue these efforts without change to the frequency. Yearly documentation will continue to be provided in the Program's Annual Reports.

1.7 Pump Test

Adopt special specific water level monitoring for performing the pump test.

1.8 Program Reporting

Annual reporting for the Project's Program will continue to be prepared. These reports will provide the analysis of all Project activities and operations. There will not be any changes to the 2012 update to the groundwater monitoring program for reporting.